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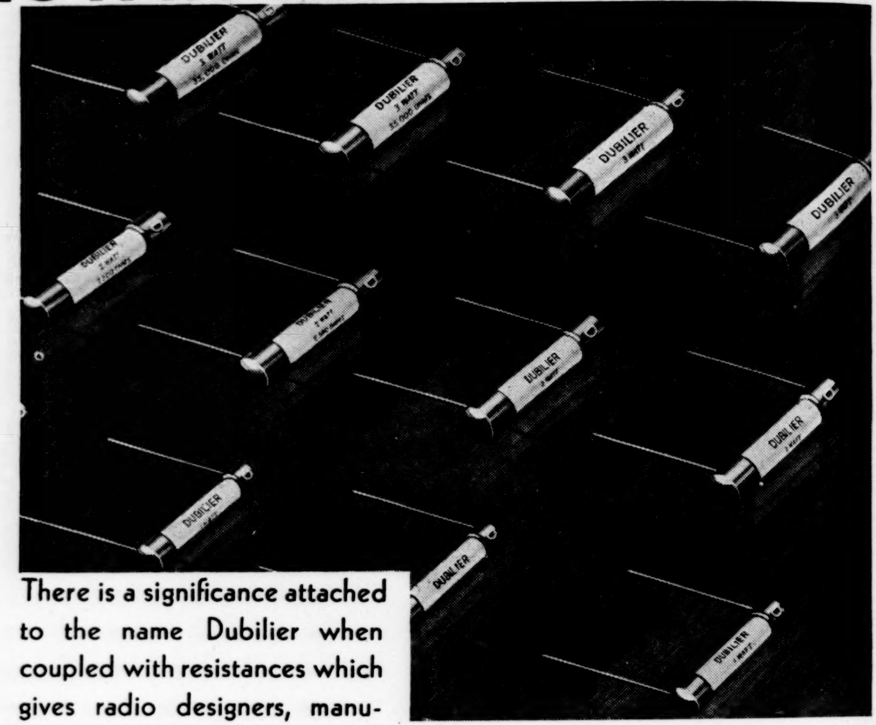

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VOL. XI. JULY, 1934. No. 130

Editorial

Electromagnetic Screening

IN a recent editorial note * we referred to a paper by Kaden in which the effect of a screening can on the magnetic field of a coil was calculated by assuming the can to be replaced by a spherical shell of the same thickness. The original paper is of a highly mathematical character, but we discussed the simple formulae obtained for the reduction of the external field, and for the effect of the screen on the inductance and effective resistance of the coil. It occurred to us that the problem might be made amenable to approximate treatment of a more elementary character by making assumptions which do not depart very much farther from the actual data than Kaden's device of replacing the cylindrical can by a sphere and the coil by a dipole at its centre. If a short-circuited ring be placed round a coil carrying an alternating current, the current induced in the ring will decrease the magnetic field in the neighbourhood of the coil, and at points not too near the coil the reduction of the magnetic field will not be greatly affected by small changes in the position of the ring. In Fig. 1, for example, the effect at a distance will be approximately the same whether there is a single turn at A, or two turns of the same total cross-section at B B^1. Except very close to the ends of the coil the effect of omitting the ends of a screening can would be very small, especially if the equivalent material were added to the cylindrical walls, thus making them thicker or longer. This suggested the idea of replacing the screening can by a short-circuited cylindrical coil or solenoid. This departs from the actual conditions merely in forcing the current to have a uniform distribution, whereas in the screening can the current density varies from point to point in the axial direction.

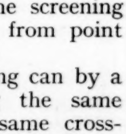

Fig. 1.

By thus replacing the screening can by a short-circuited solenoid having the same diameter and length and the same cross-section, the problem is reduced to a simple application of elementary alternating current principles. We shall compare the results thus obtained with those obtained from the spherical shell.

In the absence of the screen a voltage V applied to the coil produces a current I in

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* *Wireless Engineer*, March, 1934, p. 115.

accordance with the formula

$$V = I\ (R_0 + j\omega L_0).$$

With the screening coil in position, we have

$V = I_c(R_0 + j\omega L_0) + j\omega M I_s$ .. in the coil

$0 = I_s(R_s + j\omega L_s) + j\omega M I_c$ .. in the screen

where

I_c and I_s are the currents in coil and screen,

R_0 and R_s are the resistances of coil and screen,

L_0 and L_s are the inductances of coil and screen, and

M is the mutual inductance between the two.

Hence

$$I_s = -I_c \frac{j\omega M}{R_s + j\omega L_s} \quad .. \quad .. \quad (1)$$

and

$$V = I_c \left[R_0 + \frac{\omega^2 M^2}{R_s^2 + \omega^2 L_s^2} R_s + j\omega\left(L_0 - \frac{\omega^2 M^2}{R_s^2 + \omega^2 L_s^2} L_s\right)\right] \quad .. \quad .. \quad (2)$$

That is to say, the effective inductance of the coil is reduced from L_0 to

$$L_0\left(1 - \frac{M^2}{L_0 L_s} \cdot \frac{1}{1 + \frac{R_s^2}{\omega^2 L_s^2}}\right) \quad .. \quad (3)$$

and its effective resistance is increased from R_0 to

$$R_0 + R_s\left(\frac{M}{L_s}\right)^2 \cdot \frac{1}{1 + \frac{R_s^2}{\omega^2 L_s^2}} \quad .. \quad (4)$$

If we apply the simple formula for a very long solenoid we have

$$L = 4\pi \frac{T^2}{l} A$$

where T = turns, A = cross-sectional area of coil, and l = axial length of coil.

When the diameter of the coil is comparable with its length this expression must be multiplied by a factor k depending on the shape of the coil. If the diameter is equal to the length, $k = 0.69$. Since the number of turns in the screen is quite arbitrary we shall assume it to be the same as the number of turns in the coil.

Hence, for the coil $L_0 = 4\pi \frac{T^2}{l_c} A_c k_c$ .. (5)

and for the screen $L_s = 4\pi \frac{T^2}{l_s} A_s k_s$ .. (6)

Similarly for the mutual inductance,

$$M = 4\pi \frac{T^2}{l_s} A_c k_m \quad .. \quad .. \quad (7)$$

Thus we have

$$\frac{M^2}{L_0 L_s} = \frac{l_c A_c}{l_s A_s} \cdot \frac{k_m^2}{k_c k_s} = \frac{V_c}{V_s} \cdot \frac{k_m^2}{k_c k_s} \quad .. \quad (8)$$

where V_c and V_s are the volumes of the coil and screen, and

$$\frac{M}{L_s} = \frac{A_c}{A_s} \cdot \frac{k_m}{k_s} \quad .. \quad .. \quad (9)$$

If the thickness of the screen is t and its diameter d_s the length of wire in the coil which replaces it is $\pi d_s T$, its cross-section $t\frac{l_s}{T}$, and its resistance $R_s = \rho \frac{\pi d_s T^2}{t l_s}$; hence

$$\frac{R_s}{\omega L_s} = \frac{\rho}{\pi d_s t \omega k_s} \quad .. \quad .. \quad (10)$$

If this ratio is small compared with unity, as it will be if the screening is very effective, $(R_s/\omega L_s)^2$ may be neglected in (3) and (4).

It is to be noted that if the screen could be made of a perfectly conducting material, $R_s/\omega L_s$ would be zero.

For a manganin can with $\rho = 42 \times 10^{-6}$ ohms per cm. cube or 42×10^3 e.m. units, $r_s = 4$ cm., $t = 0.05$ cm., $f = 150{,}000$ and $k_s = 0.7$, formula (10) gives

$$\frac{R_s}{\omega L_s} = \frac{42{,}000}{2\pi \times 4 \times 0.05 \times 2\pi \times 150{,}000 \times 0.7} = \frac{1}{20}$$

For copper or aluminium or any material likely to be used for a commercial screening can, the value will be much smaller and its square can safely be neglected in formulae (3) and (4).

We have, therefore,

$$L = L_0\left(1 - \frac{M^2}{L_0 L_s}\right) = L_0\left(1 - \frac{V_c}{V_s} \frac{k_m^2}{k_c k_s}\right) \quad .. \quad (11)$$

and

$$R = R_0 + R_s \frac{M^2}{L_s^2} = R_0 + \left(\rho \frac{\pi d_s T^2}{t l_s}\right)\left(\frac{A_c}{A_s} \cdot \frac{k_m}{k_s}\right)^2$$

$$= R_0 + \frac{1}{\pi} \cdot \frac{d_s}{l_s}\left(\frac{k_m}{k_s}\right)^2 T^2 A_c^2 \frac{\rho}{t r^4} \quad .. \quad (12)$$

These results can be compared with

Kaden's formulae,

$$L = L_0\left(1 - \frac{V_c}{V_s}\cdot\frac{2}{3k_c}\right)$$

$$R = R_0 + \frac{3}{2\pi}T^2A_c^2\frac{\rho}{tr^4}$$

It will be seen that they are of exactly the same form and differ only in the value of the numerical coefficients.

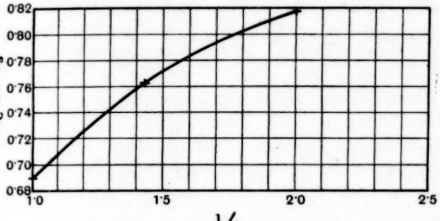

Fig. 2.

The value of k_c or k_s (Kaden's K) is plotted in Fig. 2 and can be read off for any ratio of length to diameter of either screen or coil.

The value of k_m involves many variables, but the curve of Fig. 3 gives its value on the assumption that the screen is considerably longer than the coil; in this case the exact size and shape of the coil is immaterial, the value of k_m depending only on the shape of the screen.

In the example calculated by Kaden $l_c = d_c = 3.5$ cm.; $l_s = 8.5$ cm.*; $d_s = 8$ cm. but we should assume a length $l_s' = l_s + r_s = 12.5$ cm. for our outer coil, to compensate for the absence of the ends; our screening coil will then have the same surface as the actual screening can.

From Figs. 2 and 3 we then have

$l_c/d_c = 1 \therefore k_c = 0.69$

$l'_s/d_s = 1.56 \therefore k_s = 0.78$ and $k_m = 0.84$.

Hence

$$L = L_0\left(1 - 1.31\frac{V_c}{V_s}\right) \quad \cdots \quad \cdots \quad (13)$$

and

$$R = R_0 + \frac{1.5}{2\pi}T^2A_c^2\frac{\rho}{tr^4}\cdots \quad \cdots \quad (14)$$

It must be noted, however, that V_s in our case is the volume of the actual screening coil, whereas in Kaden's formula it is the volume of a sphere of a diameter equal to the geometric mean of the three principal dimensions of the can. In the above example these two values of V_s work out at 630 and 270 cm.³ respectively. From (13) we have, therefore,

$L = L_0\left(1 - 1.31\frac{34}{630}\right) = L_0\left(1 - 0.07\right)$ and $L/L_0 = 0.93$, as compared with Kaden's calculated value of 0.88, and his measured value of 0.87.

The increase of resistance $R - R_0$ due to the screen as calculated in formula (14) is exactly half that calculated by Kaden and checked experimentally. This is what one would expect from the uniform distribution of current throughout the length of the solenoidal screen. If there are 3 paths in parallel each of 1 ohm resistance, and a current of 6 amperes divides between them in such a way that one carries 4 amperes whilst the other two carry 1 ampere each, the total dissipation is 18 watts, whereas if the current divides equally between them the dissipation is reduced to 12 watts. In the actual can the distribution will be very uneven, so that a given total current—this will not vary greatly—will cause a greater loss in the can than in the solenoid.

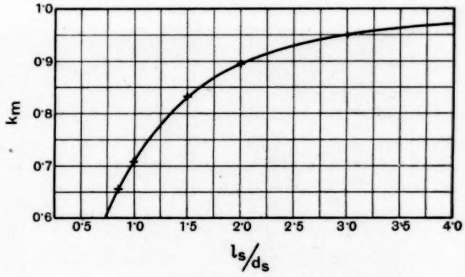

Fig. 3.

Calculation of Screening Effect

At a considerable distance from a solenoid the strength of the magnetic field is proportional to the product of the ampere-turns and the cross-sectional area of the coil, and inversely proportional to the cube of the distance. Hence the ratio of the field strength as reduced by the screen to the original field strength will be given by the formula

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* In the March editorial there is a misprint. On p. 117 at the foot of column 1, the height of the screen is given as 4.5; it should be 8.5 cm.

$$\frac{H}{H_0} = \frac{I_cA_c + I_sA_s}{I_cA_c} = \frac{I_cA_c - I_cA_s\dfrac{j\omega M}{R_s + j\omega L_s}}{I_cA_c}$$

$$= 1 - \frac{A_s}{A_c}\frac{M}{L_s}\left(1 + j\frac{R_s}{\omega L_s}\right)$$

$$= 1 - \frac{k_m}{k_s}\left(1 + j\frac{R_s}{\omega L_s}\right)$$

We have here assumed that $(R_s/\omega L_s)^2$ is negligible compared with unity, and we have used formulae (1) and (9). Putting $k_m/k_s = 1$ (see Figs. 2 and 3), we have as a close approximation

$$[H/H_0] = R_s/\omega L_s$$

and therefore from (10)

$$H/H_0 = \frac{\rho}{\pi d_s t\omega k_s}.$$

For the example of the manganin can we have already seen that for $f = 150{,}000$, the value of this ratio is 1/20, showing that the effect of the screen is to reduce the external magnetic field to a twentieth of its unscreened value. This agrees exactly with Kaden's calculated value. Hence we see that the assumption of a short-circuited solenoid of the same thickness and surface area as the can gives exactly the same result for the screening effect but under-estimates by about 50 per cent. the effective changes in the inductance and resistance of the coil within the screen. If the object of the screen were only electromagnetic it would undoubtedly be preferable to use such solenoidal screens rather than cans, but electrostatic screening has also to be considered and for this purpose the complete enclosure obtained with a can is certainly an advantage.

G. W. O. Howe.

The Future of Television

Members of the Committee appointed by the Postmaster-General to consider the development of television and the possibilities of a public service. Left to right: Sir John Cadman (Vice-Chairman), Lord Selsdon (Chairman), Mr. F. W. Phillips (Assistant Secretary, G.P.O.), Mr. J. Varley Roberts (Secretary), Mr. O. F. Brown (Department of Scientific and Industrial Research), Vice-Admiral Sir Charles Carpendale (Controller, B.B.C.), Mr. Noel Ashbridge (Chief Engineer, B.B.C.), and Colonel A. S. Angwin (Assistant Egnineer-in-Chief, G.P.O.).

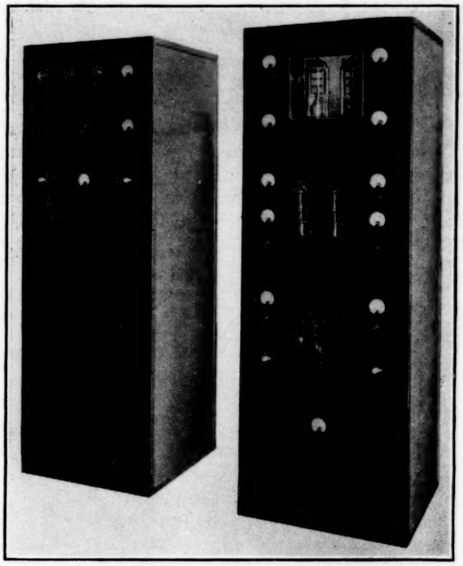
High Efficiency in Audio-frequency Amplifiers*

Illustrated by Measurements on a 250-450 Watt Amplifier

By E. K. Sandeman

THE amplifier used to illustrate the discussion below has been designed specially for use on rediffusion systems in which programmes picked up by a radio receiver are distributed at audio frequency over a wire network connected to subscribers' houses. It is of such power that no amplifiers are required at the subscribers' premises, it being only necessary to bridge a loud speaker directly across the distribution wires, suitable protective arrangements being made. The use of amplifiers of this type is not restricted to the field of rediffusion since they can be used in any installation where high power audio frequency is required, whether for distributing music in dance halls, parks and theatres, or for the transmission of speech to large assemblies of people at games, racecourses, or public functions.

This amplifier is of particular interest at the present time when fashion is favouring quiescent push-pull on the one hand and grid loading with low values of grid bias on the other. The grid bias here used is substantially the same as that for normal use of the valves in a Class A amplifier, and normal push-pull working is employed. The grid swing is so large that at the negative end the curved part of the valve characteristic is used, while at the positive end of the swing the grids are driven positive and grid current flows. The first effect is offset by the use of push-pull amplification, and the second by shunting or "loading" the grid filament circuit with resistance, the value of this resistance being so low that it is always small compared with that of the grid-filament path in the valve.



[*By permission of Standard Telephones and Cables Ltd.*]

250-450-*watt amplifier.*

This system of amplification was first used by the Bell Telephone Laboratories and has been in use by the Standard Companies for the last decade. With a normal anode dissipation of 500 watts (*i.e.*, when unloaded) it has an audio-frequency power output of 250 watts with a total harmonic content not greater than 5 per cent. of the fundamental on a *voltage* basis, and a power output of 450 watts with a total harmonic content not greater than 10 per cent. on a *voltage* basis. When loaded to give 450 watts the anode dissipation increases to slightly over 900 watts.

Expression of the ratio of harmonics to fundamental on a voltage basis gives an apparently more stringent and less favourable picture of the performance of an amplifier than does expression on a power basis, and, therefore, in the opinion of the writer, is the basis which should be used.

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* MS. accepted by the Editor, September, 1933.

Before discussing the type of amplification used it will probably save misunderstanding to summarise briefly the three classes of amplification in general use and to consider briefly the method of rating amplifiers from the point of view of power handling capacity.

Classes of Amplification

Class A.—The grid of the valve (assumed to be a triode) is biased to the mid-point of the straight part of the (negative grid) plate current grid voltage characteristic. The grid swing = twice the grid bias. (See Fig. 1. V_g = grid bias, V_{ac} = grid swing.)

Class B.—The grid of the valve is biased back to the point where the plate current becomes so small as to be negligible.

The grid swing = twice the grid bias. (See Fig. 2.)

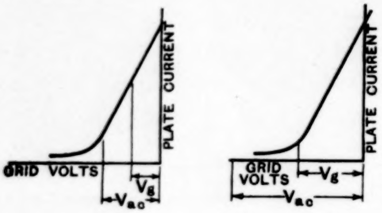


Fig. 1. Fig. 2.

Grid bias and grid swing in (Fig. 1) Class A amplification, and (Fig. 2) Class B amplification.

Class C.—As Class B, but the grid swing is greater than twice the grid bias and the grids of the valves are driven positive. (See Fig. 3.) Quiescent push-pull, I understand, to embrace both Classes B and C.

A further class which deserves at least to be recognised, because of the extent of its use, may be called Class D.

Class D.—Here again the grid swing is greater than twice the grid bias, but the bias is usually as shown in Fig. 4, and the grid-cathode circuit is shunted with a resistance which is made as low as possible consistent with the production of adequate grid swing across it, without overloading the previous stage. The grid bias is then adjusted so that maximum power output is obtained for a given harmonic content. So far from this being obtained with a value of bias corresponding to Class B operation, it is usually obtained with a bias rather less than that required for Class A operation.

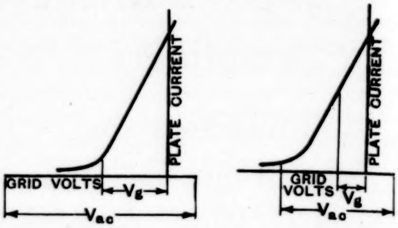


Fig. 3. Fig. 4.

Grid bias and grid swing in (Fig. 3) Class C amplification, and (Fig. 4) Class D amplification.

In the case of power valves where no special means such as water cooling are used to provide an escape for the heat released by the anode dissipation, a limitation is imposed on the grid bias so that it is not possible to obtain the theoretical maximum of output power, the practical limit of power handling capacity being reached with a value of grid bias approximately the same as that employed when the valves are used for Class A amplification. This is well illustrated in Fig. 7.

Recently a number of writers have defined as Class B the type of amplification in which the grid has zero bias and the grid cathode circuit is shunted with a resistance. As this does not appear to be consistent with the older definitions above no attempt has been made to reconcile it with them. It appears to be closely related to Class D as above defined.

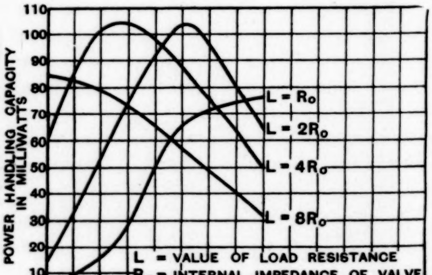


Fig. 5.—*Variation of power handling capacity of 4101-D valves with grid bias and load resistance when grid cathode circuit is shunted with 60,000 ohms.*

In the amplifier described below the grid bias is limited by anode heating. Incidentally, it is interesting to watch the anodes grow cool when the load is applied and the energy, which under no load conditions is dissipated in heating the anode, is transferred to the output circuit as audio-frequency power. This occurs in spite of the fact that the total power taken by the anode circuit is increased when the load is applied.

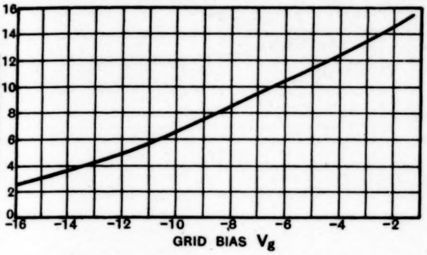


Fig. 6.—*Plate current grid voltage characteristic of* 4101-*D valves.*

Method of Rating the Power Handling Capacity of Audio-frequency Amplifiers

To avoid misunderstandings it is evidently desirable to have a universal method of rating amplifiers. Until very recently a considerable amount of confusion has been caused because certain manufacturers rated their amplifiers on anode dissipation while others used a figure intended to represent the audio-frequency power supplied by the amplifier to the load.

The anode dissipation has the merit that it can be easily derived from the valve constants without any subsidiary measurements, but as the anode efficiency of amplifiers varies rather widely it is of little practical value to the user; it does not give any indication either of the power required to operate the amplifier or the power delivered by the amplifier. The audio-frequency power output is evidently the figure which is of more interest to the user.

The practical condition which limits the power output of an amplifier is the degree of distortion occurring as measured by the amount of spurious harmonics of the input frequencies which occur in the output. It is convenient to measure amplifiers with single frequencies, and so the practice has arisen of rating amplifiers in terms of the single frequency power output for given percentage harmonic content. Unless the harmonic content is specified, any statement of power output is rather vague, if not entirely meaningless. Some differences have arisen in the value of harmonic content chosen as the limiting factor; the condition which appears to be assuming greatest popularity is that in which the combined voltage of all the harmonics is equal to 5 per cent. of the voltage of the single frequency test tone (a figure of 10 per cent. has also been used). At other times the condition has been taken that the power in the harmonics shall not exceed 5 per cent. or 10 per cent. of the fundamental power. Since the power in a circuit is proportional to the square of the voltage the figure obtained by expressing the harmonics on a power basis is much smaller than the figure obtained by expressing them on a voltage basis, and by juggling between power and voltage rates a bad amplifier may be made to look like a good one as far as the magnitude of the figure of merit is concerned, *e.g.*, an amplifier with a harmonic content of 10 per cent. on a voltage basis has a harmonic content of 1 per cent. on a power basis. Judged by the criterion which is repeated below, an amplifier with a harmonic content of 5 per cent. on a power basis is not giving a very good performance, although the figure 5 might lead the unwary to expect a high grade of reproduction.

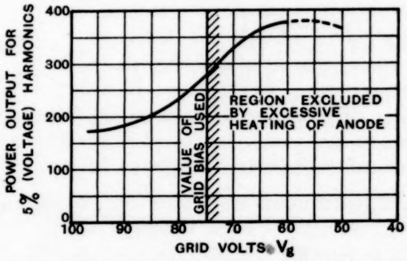


Fig. 7.—*Variation of power handling capacity with grid bias for 250–450–900 watt amplifiers.*

It is therefore suggested that the power handling capacity of an amplifier shall be taken as that power at which the total harmonic voltage amounts to 5 per cent. of the voltage of the fundamental test tone frequency.

Since with amplifiers other than Class B and Class C the percentage of harmonics increases with power output and since the law of increase varies from amplifier to amplifier it is strictly not sufficient to specify the percentage harmonics at one power only, because there is from the practical point of view no definite value of harmonic percentage which can be set as a limit. For instance, one amplifier which handles 15 watts at 5 per cent. harmonic may handle 40 watts at 10 per cent. harmonic, while a second amplifier which handles 15 watts at 5 per cent. harmonic may handle only 20 watts at 10 per cent. harmonic. It is evident that since in practice the permissible loading with speech or music is determined by the frequency of occurrence of a certain degree of harmonic production, and since quite high percentages of harmonic production are tolerated for short and rare intervals, the first of the above amplifiers is better than the second.

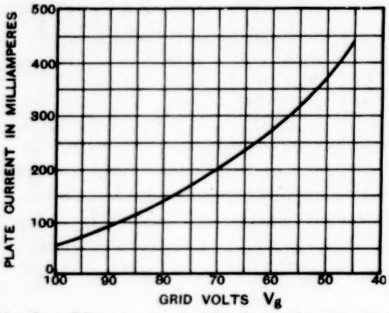


Fig. 8.—*Plate current grid voltage characteristic of 4212-D valve.*

For this reason, ratings on both 5 per cent. and 10 per cent. (voltage) harmonic have been given in this description.

Adjustment of Grid Bias for Maximum Power Output

The curves obtained on an amplifier by measuring variation of power output for constant harmonic content with change of grid bias and change of anode load are very instructive. Curves taken on the 250–450-watt amplifier are limited by the fact that the maximum anode dissipation is such that the maximum power output obtainable from consideration of circuit constants cannot be reached, and, as a matter of interest, curves taken on a smaller type of valve where the limit of anode dissipation is not reached are given in Fig. 5.

This shows the variation of power handling capacity with grid bias for a single valve amplifier operating on 130 volts, using a 4101–D valve (the characteristic of which is shown in Fig. 6) under different conditions of output load.

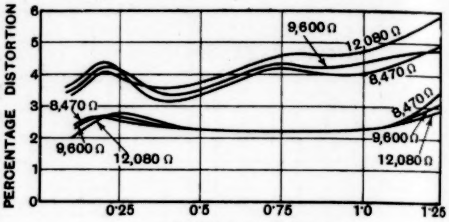


Fig. 9.—*Variation of harmonic content with power output Class B amplifier.*

Fig. 7 shows the same for the 250–450-watt amplifier described below, for one value of load impedance. This amplifier uses two 4212–D valves in push-pull, the characteristics of which are shown in Fig. 8.

The curves in Fig. 5 are taken with values of resistance facing the valve plate circuit, varying from 1 to 8 times the anode impedance of the valve. Each point plotted represents the value of power under the specified conditions at which the total of all harmonics just reaches 27.8 decibels (3.2 nepers) below the fundamental or about 4 per cent. on a voltage basis. (This value was chosen in this particular case because it is the value specified by the Comite Consultatif International for the rating of amplifiers on broadcasting circuits.) The optimum grid bias being that at which maximum power is obtainable, it is

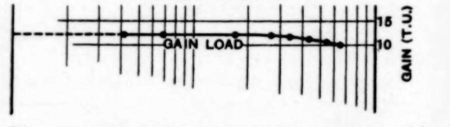


Fig. 10.—*Variation of harmonic content with power output Class D amplifier.*

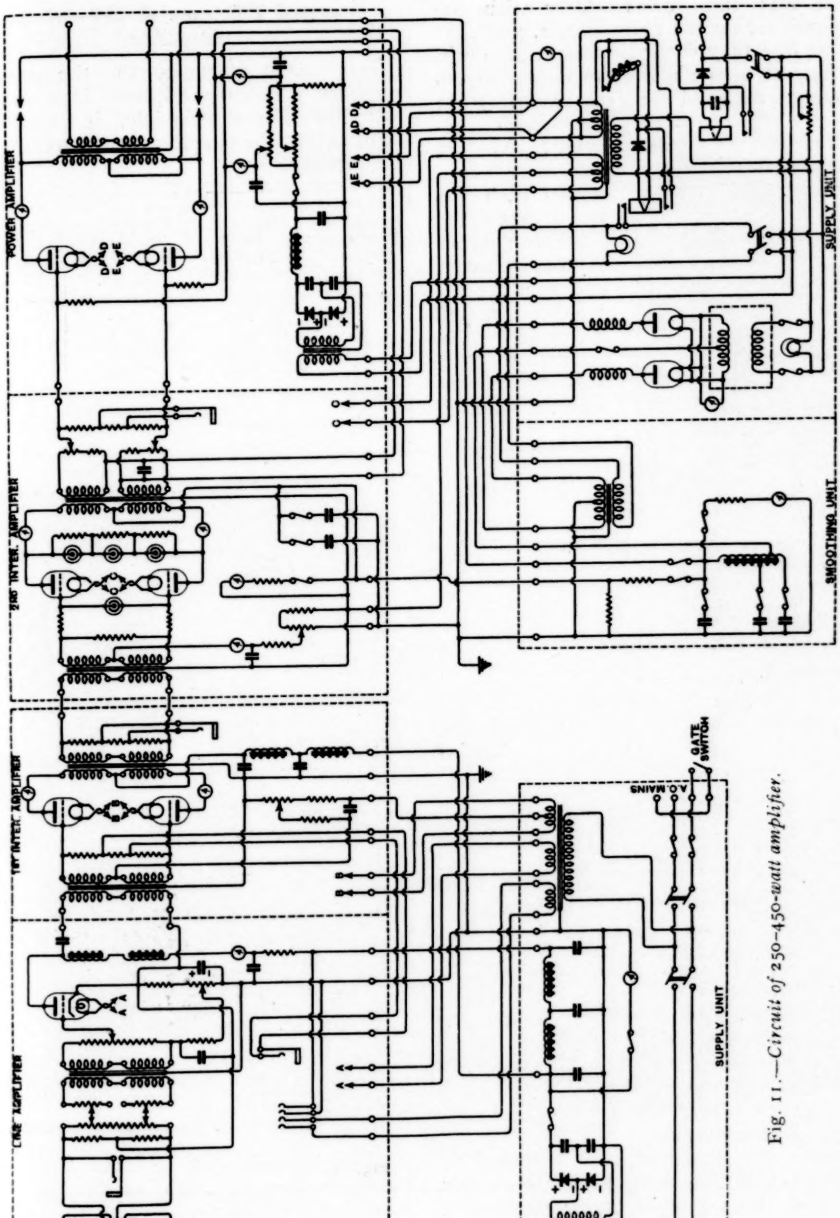
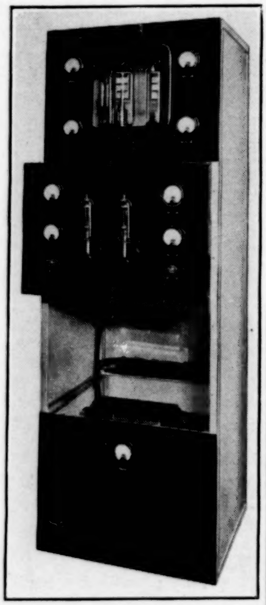

POWER AMPLIFIER
2ND INTER. AMPLIFIER
1ST INTER. AMPLIFIER
LINE AMPLIFIER
SUPPLY UNIT
SMOOTHING UNIT
SUPPLY UNIT
A.C. MAINS
GATE SWITCH

Fig. 11.—*Circuit of 250–450-watt amplifier.*

evident that this varies widely with the impedance facing the plate circuit, and that the best bias may occur neither at zero grid volts nor at zero plate current (see Fig. 6 for characteristics of the 4101–D valve) but somewhere between. (We are not here concerned with the fact that the maximum power obtainable varies also with the impedance facing the plate.) The optimum grid bias also varies with the value of resistance used to shunt the grid filament circuit. It will now be clear that close attention to the adjustment of the grid bias is essential if the maximum efficiency is to be obtained from an amplifier.



[*By permission of Standard Telephones and Cables Ltd.*]

Fig. 12.—*Illustrating method of pulling out drawers.*

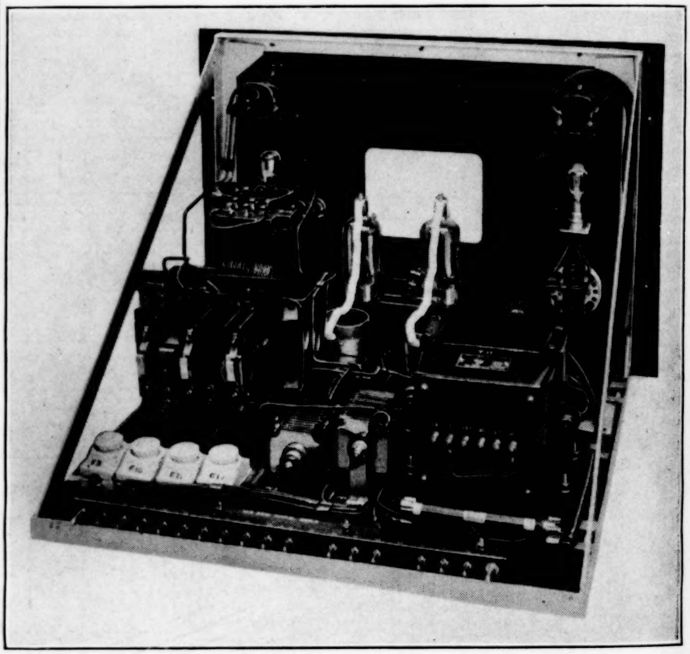
(*Right*) Fig. 13.—*Photograph of drawer alone.*

As Fig. 7 shows, it was not found possible to operate the amplifier here described at the value of grid bias giving maximum power because of the excessive anode dissipation resulting. The criterion of power handling capacity here used was 5 per cent. on a voltage basis.

Observed Efficiency of 250–450-watt Amplifier

The anode efficiency on the 250-watt amplifier, which was adjusted in accordance with the above principle, is remarkably high, as the following measurements taken on one model show :

Audio-Frequency Output—Watts.	Anode Dissipation.	Percentage Harmonics on Voltage Basis.	Total kva. Taken from Mains.
0	496	—	1.57
200	620	3.5	1.77
250	—	5.0	—
400	806	7.0	1.9
450	920	10.0	—



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There is some evidence that Class B (and, therefore, Class C) operation compares much more unfavourably with Class D operation, even than is indicated by Fig. 7, which only shows a comparison of performance at constant harmonic content.

Fig. 9 is taken from Fig. 11, in a paper by Roy E. Barton in the journal of the *A.I.E.E.* for July, 1931, called "High Audio Power from Relatively Small Tubes." This shows that the percentage harmonic content of a Class B amplifier is independent of power output, and is substantially constant at the value obtained on full load and equals about 5 per cent. of the fundamental on a voltage basis when both second and third harmonics are taken into account.

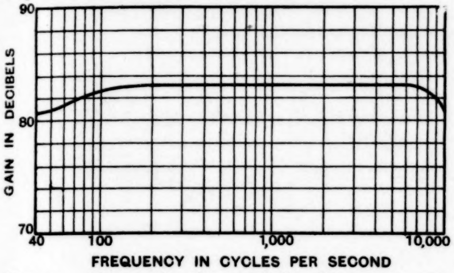


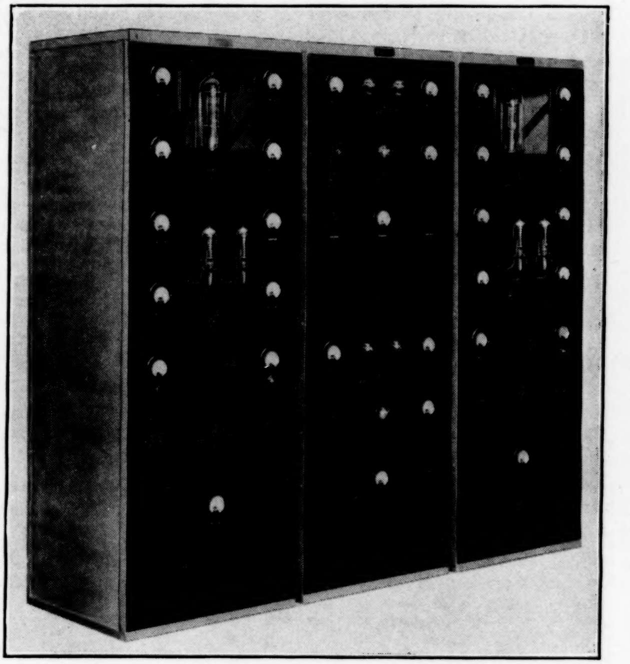
Fig. 14.—*Frequency characteristic of 250–450–900 watt amplifier.*

A Class D amplifier, on the other hand, only reaches this value of harmonic content at full output power, and below full output power the percentage content falls away to negligible proportions very quickly.

Fig. 10 is taken from Fig. 9, in a paper by F. C. Willis and L. E. Melhuish in the *Bell System Technical Journal* for October, 1926, called "Load Carrying Capacity of Amplifiers." This shows measurements of percentage harmonic content on a Class D amplifier for varying values of output power and it is evident that below the rated output corresponding to 5 per cent. harmonic output, the harmonic content falls away very rapidly.

In favour of Class B operation it will be appreciated that the anode current is zero in the absence of speech or music, so that the effective anode efficiency is very high compared with that of Class A or D amplifiers provided the distortion is tolerable. For many uses this is the case, particularly where only one stage of Class B amplification is involved. In other cases the very small saving in annual charges on power is not worth the extra distortion.

Although all the relevant data on the performance of the 250–450-watt amplifier are given in the figures above, it may serve to lend them substance if a few particulars are given of the amplifier on which they are obtained. The circuit of the amplifier is given in Fig. 11. It is a four-stage amplifier, each stage being mounted in a drawer which pulls out completely, giving extreme accessibility; all connections are made through plugs and jacks at the back. The amplifier is entirely self-contained and operates from any standard A.C. mains supply, the power supply units being mounted in separate drawers. The photograph on page 351 depicts a single amplifier, while Fig. 15 shows double equipment containing two such



[*By permission of Standard Telephones and Cables Ltd.*]

Fig. 15.—*Double programme equipment.*

amplifiers, mounted in a rediffusion equipment, the outer racks each contain one output stage and the penultimate stage and the necessary power supply equipment, while the centre rack contains the two sets of input stages.

Fig. 12 illustrates the way in which the drawers pull out, and Fig. 13 shows a drawer taken out of the rack, the drawer in question containing the high tension rectifier unit for one power amplifier.

Fig. 14 shows a gain frequency characteristic taken on one model.

Twenty-six of these amplifiers have already been supplied to Messrs. Standard Radio Relay Services.

These amplifiers are designed to meet the requirements of Messrs. Standard Radio Relay Services, and contain a number of features suggested by Captain P. P. Eckersley of this company. A point of particular interest is the introduction of balancing potentiometers in the input of the power stage to adjust for small variations in the valve characteristics. This feature is due to Mr. P. Adorjan of the above firm.

I should like to acknowledge the help which I have received from my colleagues in Standard Telephones and Cables during the preparation of this article, particularly from Mr. P. L. Tabois, who was responsible for the bulk of the design work; and Mr. A. J. Watt, who carried out the tests on the amplifier.

APPENDIX

It may be of some interest to describe the method used for the harmonic measurements appearing in Figs. 5 and 7. It is the simplest and most obvious method possible. A pure sine wave is fed into the input of the amplifier and the output from the amplifier under test is fed into two alternative paths, one containing a variable attenuator (attenuator 3, Fig. 16) and the other a high pass filter suppressing the fundamental of the sine wave but passing *all* its harmonics.

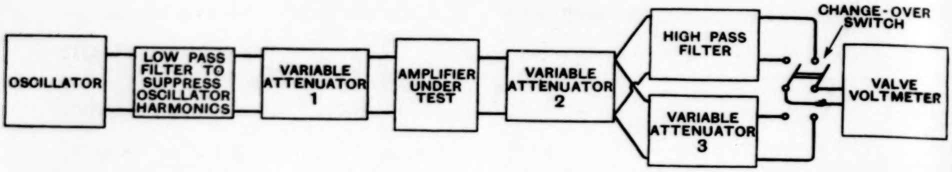


Fig. 16.—*Harmonic measuring circuit.*

The attenuator is adjusted until the fundamental voltage measured across the output of the attenuator has the same magnitude as the harmonic voltage measured across the output of the filter; since the attenuator is distortionless the voltage measured really represents fundamental plus harmonics, but as the harmonics are small they can evidently be neglected.

If the loss in the pass range of the filter is x decibels and the reading on the attenuator after the above adjustment is y decibels, then the ratio of harmonic to fundamental is given by $x - y$ decibels. The harmonic expressed as a percentage of the fundamental is given by

$$H\% = \left(100 \text{ Antilog}_{10} \frac{x - y}{10}\right)\% \text{ on a power basis}$$

$$\text{or } \left(100 \text{ Antilog}_{10} \frac{x - y}{20}\right)\% \text{ on a voltage basis.}$$

The circuit arrangement is given in Fig. 16. Attenuators 1 and 2 are inserted purely for convenience, since if attenuator 2 is increased when attenuator 1 is decreased and vice versa, the fundamental output remains constant while the harmonic output varies and can easily be adjusted to be the same as the fundamental output. This is useful when determining the power output for a given percentage harmonic, attenuator 3 then being kept fixed at a value corresponding to that percentage.

This method of measurement is the most critical possible, because it includes all harmonics and the only possible source of error is failure of the filter to suppress the fundamental effectively; as, however, this tends to make the reading of harmonic content too high, measurements made in this way are likely to give a conservative idea of an amplifier's performance rather than a generous one. In the measurements made, of which results are given above, the filter used had a minimum attenuation of 60 decibels in the non-pass range, so that errors due to fundamental leak were negligible.

Gas Discharge Tube as Intervalve Coupling *

The Practical Application for D.C. Amplification

By H. Smith, B.A., D.Sc.; and E. G. Hill, M.Sc., Ph.D., F.Inst.P.

ALL forms of interstage valve couplings are methods designed to transfer voltage changes occurring at the anode of one valve to the grid of the succeeding one and at the same time to obviate the difficulty that a mean difference of potential of the order of 100 volts exists between these two points. For sustained frequencies of more than 50 cycles, either electromagnetic or electrostatic methods of coupling can be satisfactorily used. When consideration has to be paid to the amplification of transients, impulse voltage changes, or maintained voltage changes (so-called D.C. amplification), or frequencies much below 50 cycles, other methods must be employed. Battery coupling devices have been used to deal with these latter problems, but considerable practical difficulties are always encountered if the signals to be amplified are of small magnitude. For example, if the signal voltage is 0.1 volt, the coupling battery voltage must be constant to at least 0.01 volt, which imposes a required constancy of one in ten thousand. This condition is unlikely to be fulfilled except in very specially constructed coupling batteries. If the signal is smaller than the above value all forms of battery coupling are impracticable.

It is to the solution of this difficult problem of D.C., or very low frequency amplification, that the gas discharge tube is particularly well adapted as an intervalve coupling device, owing to its current-voltage characteristic. It was originally devised by the authors for laboratory work in connection with the amplification of very small photo-electric currents.† The method proved so successful that it appeared that its application could have a much wider scope; and the object of the present paper is to bring it to the notice of other workers by giving an account of the general principles underlying its use.

Fig. 1 shows diagrammatically how a discharge tube is connected between two valves to make use of its voltage current characteristic in an interstage coupling. A resistance R is placed in the anode circuit of the valve V_1 and the glow tube is connected directly between the anode of V_1 and the grid of the next valve V_2. A grid resistance r is connected between the grid of V_2 and a negative bias voltage.

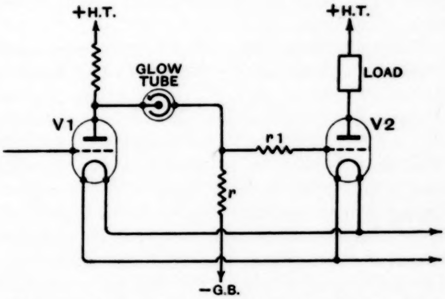


Fig. 1.—*Connection of discharge tube between two valves as an interstage coupling.*

Owing to this method of connecting up the discharge tube, it will be seen that it is an essential feature that the striking voltage should be of the order of what can usually be applied to the plate of a valve. There are a number of gas discharge tubes on the market fulfilling this condition and for the most part these are Neon filled. The striking voltages required vary with the design, in some cases being as low as 120 and in others as high as 170; in all cases the discharge potentials are lower.

To understand how the gas discharge tube functions when applied to the problem of

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* MS. accepted by the Editor April, 1934.

† See Patent Specification No. 369,578.

interstage coupling, it is necessary to examine its voltage current characteristic. The type of tube considered is one where the electrodes are so disposed that the discharge consists almost entirely of the negative glow and where the discharge current does not exceed the limit set by the abnormal cathode fall. The construction of tube preferred by the authors has two coaxial cylinders for electrodes and is Neon filled, the discharge potential being 120 volts.

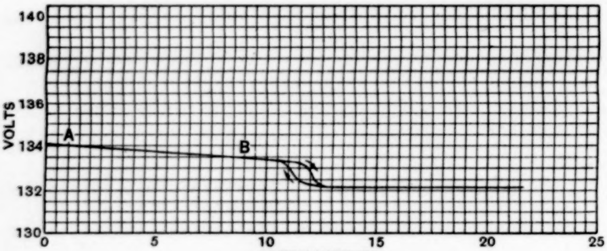


Fig. 2.—*Voltage current characteristic of discharge tube.*

The voltage current characteristic of such a tube is shown in Fig. 2, when the tube is connected up in circuit as given in Fig. 1. Under these conditions the discharge does not exhibit the familiar " backlash " (which ordinarily amounts to about 15 volts with this particular tube) and it commences almost imperceptibly at just over 134 volts, while the current at this stage can be maintained indefinitely at less than 0.1 microamp. The characteristic falls slightly till a current value of just above ten microamperes is reached. It then suddenly becomes steeply negative and a distinct change in the appearance of the discharge takes place. From about twelve microamperes onwards the characteristic is almost flat. The characteristic can be exactly retraced except that in the neighbourhood of the unstable portion a hysteresis loop is formed as shown in the figure.

This information can now be applied to explain the circuit shown in Fig. 1. The characteristic shows, except at the break made by the short unstable region, that the potential across the tube remains very nearly constant for all values of the discharge current. Hence any voltage variations occurring at the anode of V_1 (Fig. 1) will be reproduced on the grid of V_2. Provided therefore that the current in the discharge tube is small compared with the plate current V_1, the arrangement will constitute a fully efficient interstage coupling.

The voltage swing of the grid of V_2 can be calculated from the magnitude of the changes in current flowing through the grid resistance *r*. If, for example, this is two megohms then a variation of eight microamperes will give a grid swing of sixteen volts. In this particular case, therefore, a suitable part of the characteristic for the discharge tube to work on is between one and nine microamperes. To ensure that the tube is working over this part of its characteristic the voltage of the " bias " battery must be correctly adjusted. The actual grid potential will be the difference between the applied bias voltage and the potential produced across the grid resistance by the glow discharge current. A suitable value of bias voltage would therefore be −20 volts, since with one microamp flowing the grid volts would be −18, and with nine microamperes flowing the grid voltage would be −2. This will correspond to a voltage change in the preceding anode of 15.5 volts. the slight interstage amplification being due to the fact that the characteristic is slightly negative and not flat.

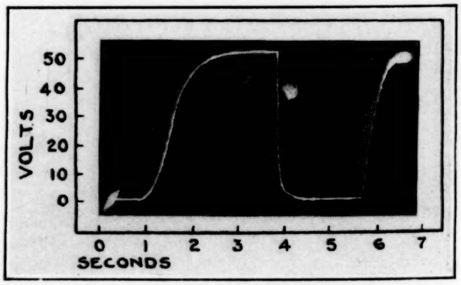


Fig. 3.

An important point that should be borne in mind is that the function of the grid bias battery is to select the part of the characteristic over which the discharge tube works; it does *not* control the grid potential of V_2. An increase in the negative value of the bias battery moves the working point farther to the right, and increases the discharge current through the grid resistance. As the discharge tube characteristic is nearly flat, the increase in potential drop down the grid leak almost exactly compensates for the change in bias battery voltage.

Other points that should be borne in mind when designing a discharge tube coupled amplifier are as follows:—

(*a*) The anode resistance R of the valve V_1 should be chosen to suit the particular valve, the value must be small enough to provide, in conjunction with the H.T. supply, a potential across the discharge tube sufficient to strike it, and large enough to give efficient amplification. A suitable choice would be 100,000 ohms with an H.T. supply of 200 volts, and a suitable valve would be one with an A.C. resistance of 150,000 ohms when biased to the optimum working point.

(*b*) The resistance r must be large enough to limit the discharge current to values negligible compared with the plate current in V_1. It must, however, be small compared with the grid impedance of V_2. A value of one or two megohms is satisfactory.

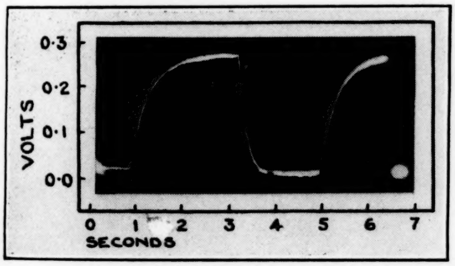


Fig. 4.

(*c*) It is also advisable to insert a resistance of about 2 megohms (r_1 in Fig. 1) between the discharge tube and the grid of V_2, as this will suppress any parasitic oscillations that may be set up in the circuit.

To illustrate the performance of a discharge tube coupled amplifier, some cathode-ray oscillograph photographs of voltage-time curves are appended. Fig. 3 is a voltage-time curve showing the discharge of a condenser through a resistance, the time base being linear and of seven seconds' duration. For this the condenser was directly coupled to the oscillograph and charged to a value of about 50 volts. To obtain the curve in Fig. 4, the same condenser was connected to the input grid of a discharge tube coupled amplifier, the output anode of which was connected to the oscillograph. The time base was the same as before, but the peak condenser charge was only 0.25 volt. These photographs show that no distortion occurs at these extremely low frequencies.

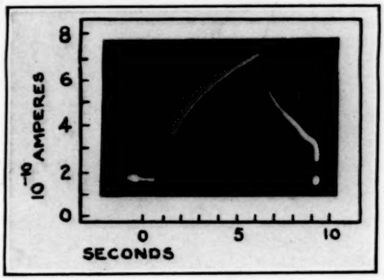


Fig. 5.

Fig. 5 illustrates an application of the amplifier to the investigation of the response of a selenium cell to very weak illumination. The time base here is ten seconds and the illumination intensity on the cell so low that the response current did not exceed 10^{-9} amperes. If more than one stage of discharge tube coupling is employed the response of such cells can be examined at much lower intensities. The cathode-ray oscillograph used was the Cossor type *C* under ordinary conditions.

The Degree of Amplitude Modulation

Some Notes on Practical Measurement

By L. F. Gaudernack

(Natuurkundig Laboratorium der N. V. Philips, Gloeilampenfabricken)

(Concluded from page 301 of last issue)

VI. Description of a Direct-reading Modulation Meter

The different methods proposed for the measurement of the degree of amplitude-modulation may be classified in the following way:

(*a*) Pure low-frequency measurements.
(*b*) Pure high-frequency measurements.
(*c*) Measurement after rectification.

Method (*a*) is generally based on some known static relation between voltage or current of the modulating frequency and the amplitude of the modulated current.

However, due to possible fall or rise of sidebands in the H.F. circuits, this method is only useful as a control method and then only when some sort of amplitude-indicating instrument is used for the measurement of the L.F. quantity (usually a triode peak voltmeter).

Amongst methods (*b*) the rise of effective value due to modulation is sometimes used for quickly checking the modulation. This method has the following main drawbacks: (1) The rise is relatively small. (2) In the presence of non-linearities and/or harmonics it gives false results. It may thus only be used as a check for the ideal case, *i.e.*, either (1) when mean amplitude during modulation is independent of m or (2) the envelope is pure sinusoidal (no harmonics).

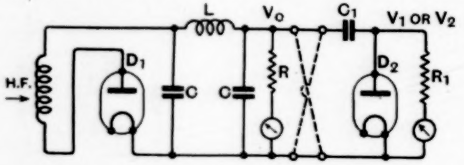


Fig. 10.

The use of a cathode-ray oscillograph for measuring modulation belongs also to class (*b*). This method is perhaps the one which most directly gives a qualitative picture of the modulation process. However, due to the smallness of the screen picture and lack of sharpness of the "spot" the accuracy for quantitative determinations is rather limited.

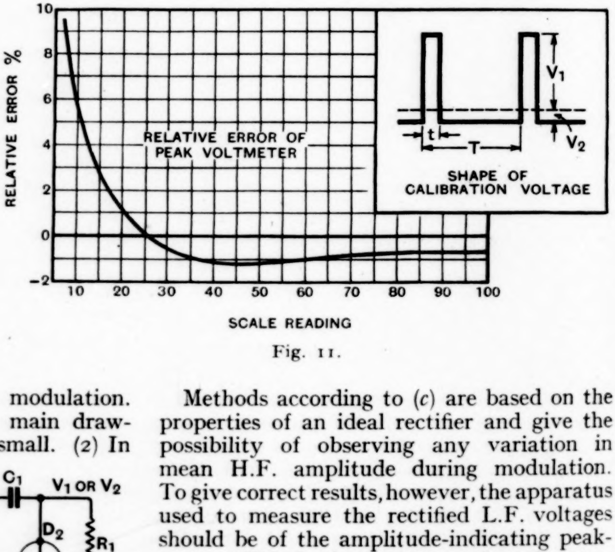


Fig. 11.

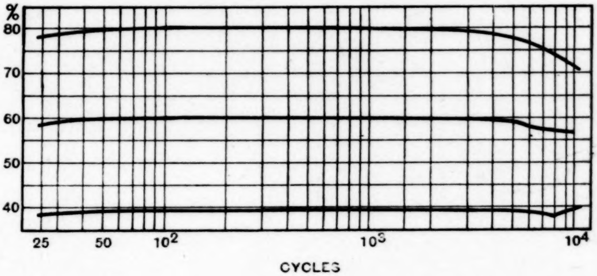
Methods according to (*c*) are based on the properties of an ideal rectifier and give the possibility of observing any variation in mean H.F. amplitude during modulation. To give correct results, however, the apparatus used to measure the rectified L.F. voltages should be of the amplitude-indicating peak-type. (Slide-back or peak-triode voltmeter, oscillograph.)

We will give a *résumé* of what we require of a modulation meter:

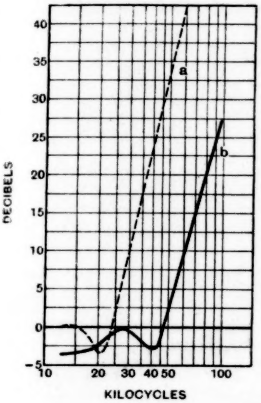
(1) The principle of measurement must be in accordance with the definition of the quantity to be measured. As the modulation depth is defined as a ratio between *amplitudes*,

this means that some peak measuring instruments must be used. Measurement in the respective H.F. field is necessary.

(2) Both the " up " and the " down " depth should be measurable, and also the mean H.F. current or some quantity proportional to this value.



(*Above*) Fig. 13.



(*Left*) Fig. 12.

(3) The low-frequency response curve, *i.e.*, measured modulation-depth against modulation-frequency should be a straight line from 30 to 10,000 cycles per sec., *also* for considerable L.F. distortion in the amplitude-enveloping curve.

(4) For convenience the instrument should preferably be *direct-reading*, some pointer indicating directly the measured value on a scale.

(5) The instrument should be self-contained and operated from the A.C. network—this for simplicity of operation.

(6) The accuracy of the measured result should be within a few per cent.

(7) The H.F. energy absorbed by the instrument should be as small as possible.

We shall now describe an instrument of the class C which has been developed according to the above specifications and which has been for some time in use at this laboratory.

Briefly, the instrument is built up of a linear high-voltage diode rectifier D_1, a low-pass filter (*L-C-C*) with a terminating resistance *R* which also serves as load resistance for the rectifier and a diode peak-voltmeter $C_1R_1D_2$ for the measurement of the rectified L.F. peak voltages (*see* Fig. 10).

The measurement of both degrees " up " and " down " is made possible by commutating the L.F. peak voltmeter as indicated by the dotted lines in the figure. Assuming that the diode and filter together with resistance *R* are rightly proportioned, we find in the voltage across the resistance *R* an exact reproduction of the amplitude-function to which the H.F. energy is modulated in the form of a D.C. voltage V_0 plus an alternating voltage with peaks V_1 and V_2. According to definition the two modulation degrees then are

$$m_1 = \frac{V_1}{V_0} . 100 \% \quad m_2 = \frac{V_2}{V_0} . 100 \%$$

If we keep V_0 constant V_1 and V_2 directly gives the two degrees of modulation, it is seen thus, that if we have a direct reading low-frequency peak-voltmeter the convenience of direct reading is readily obtained.

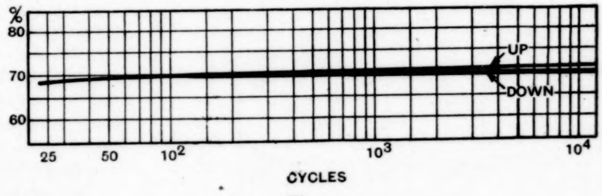


Fig. 14.

For this peak-voltmeter a diode-rectifier is used with a high C.R. constant, the input impedance of this voltmeter being so high, that the extra load on *R* due to the paralleling of the voltmeter may be neglected. This voltmeter was calibrated by means of an impulse voltage, of the form sketched on Fig. 11. The result of the calibration is shown in Fig. 11, from which it is seen that from 20 to 100 deg. (corresponding to 12 to 60 volts) this voltmeter reads the peak voltage within ± 1 per cent. accuracy.

The form of this correction curve is to be explained from the fact that without external voltages applied to the valve some electrons still flow to the anode, giving a small drop (1.1 volt) across R_1 This " bias " voltage gives at small voltages a positive error and at greater voltages it counteracts the normal error of such a voltmeter (reading less than peak). As to the design of the low-pass filter *L-C* the following requirements are to be fulfilled :

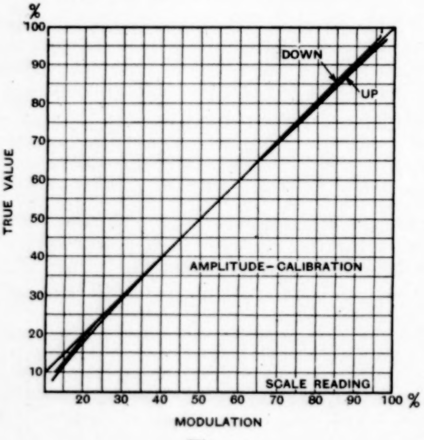


Fig. 15.

(1) In order to keep high-frequency voltages out of the L.F. peak-voltmeter, the attenuation for the lowest " high-frequency " which is to be measured should be at least 40 db.

(2) Theoretically, the cut-off frequency could be placed at some frequency slightly above 10 kc/s, as is shown by the curve (*a*) of the accompanying Fig. 12 where the cut-off lies at 24 kc/s. Measurements with such a filter where the " up " modulation was kept constant respectively on 39.2–60.0 and 80 per cent. are given in Fig. 13. As will be seen from these curves, the readings are right for smaller degrees of modulation where no distortion occurs ; for greater degrees, however, where some distortion is to be expected, we find increasing faults in the range of frequencies where the harmonics fall in the attenuation range of the filter (above cut-off). This is due to the fact that we (according to definition) measure the modulated low-frequency *peak* voltages and these values are, as we have demonstrated, greatly dependent on the amount of harmonics. From this it is seen that the cut-off frequency must be placed safely above the important harmonics of the highest modulating frequency (10 kc/s).

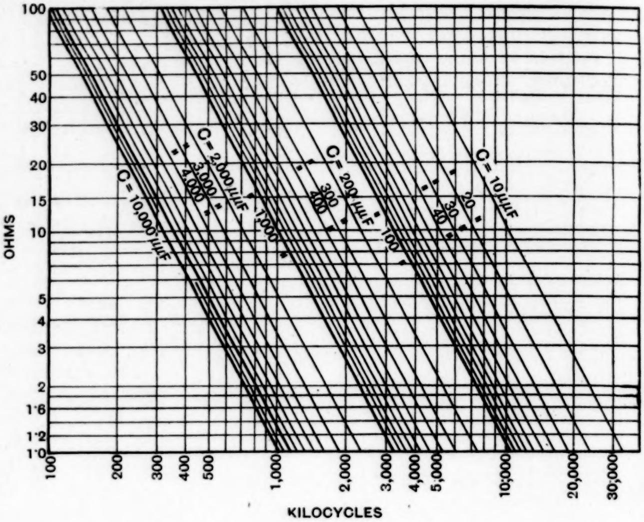


Fig. 16.

The filter finally adopted has a cut-off frequency of 50 kc/s and an attenuation curve shown as (*b*) in Fig. 12.

Measurements with this filter for a constant degree of modulation of 70 per cent. are shown in Fig. 14, from which it is seen that the frequency response from 25 to 12,000 cycles per sec. is linear within ± 0.25 db.

The filter is designed to work on a terminating resistance of $R = 8{,}000\,\Omega$, the D.C. voltage V_0 across this resistance corresponding to the *mean* amplitude is about 60 volts.

The energy absorbed from the high-frequency field is ca. 1 watt. The accuracy of the measured degree of modulation at 500 c/s can be seen from the calibration curve in Fig. 15. From 30 to 100 per cent. the relative fault is well within 1.5 per cent. and increases for smaller degrees due to the above-mentioned property of the L.F. peak-voltmeter.

It is sometimes useful to use an input circuit which is tuned to the carrier. In order to have not more than 5 per cent. fall for the 10 kc/s side bands this circuit must have a certain damping, the value of which is to be found on the graph of Fig. 16 for different values of tuning capacity and carrier frequency. In general, it is recommended to avoid this complication by using an untuned input circuit.

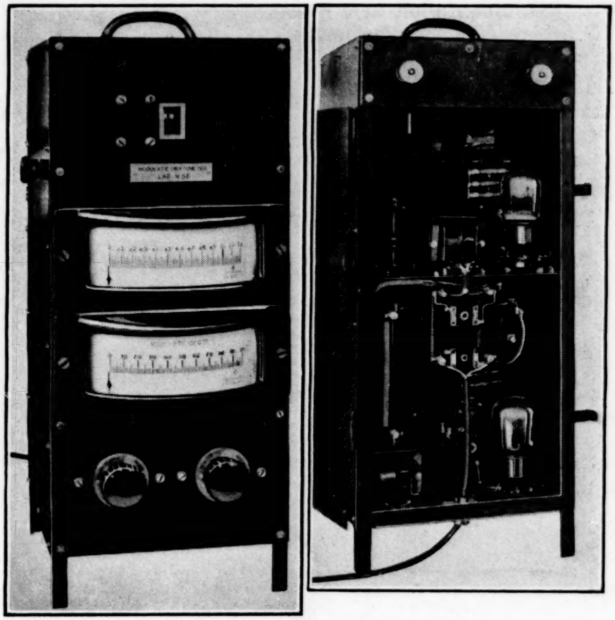


Fig. 18.—*Front and back views of the modulation meter.*

A complete diagram of connections for a meter constructed on these lines is given in Fig. 17.

A general idea of constructional features may be had from the photos in Fig. 18, showing front view and some details of interior mounting. A switch has been added to short-circuit the meters before switching over from "up" to "down" measurement.

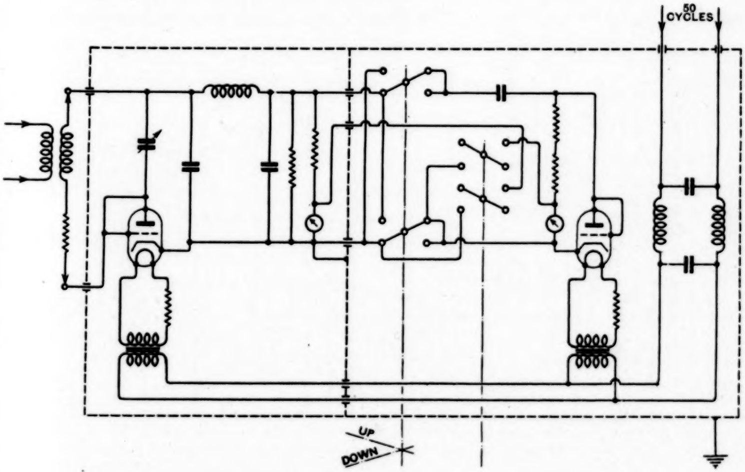


Fig. 17.—*Complete circuit diagram of the modulation meter described.*

VII. Description of a Direct-reading Ripple-meter

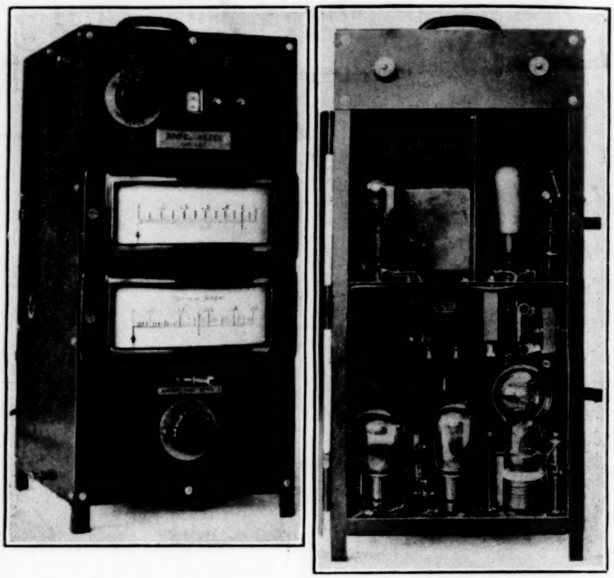


Fig. 20.—*Direct reading Ripple-meter. Front and back views.*

Due to A.C. components in the energy sources some extraneous modulation of small degree called "ripple-modulation" is present to various degrees in almost every transmitter. A so-called "ripple-meter" was constructed along the same lines as just described in order to measure modulation degrees from 0.01 per cent. to 5 per cent. The principle *C* of measuring after rectification was adopted, however, in order not to arrive at inconveniently high D.C. voltage after rectification V_0 a one-stage resistance amplifier was inserted between the H.F. filter and the L.F. triode voltmeter.

This necessitated the addition of some calibration method, the one adopted being to apply a known 50-cycle voltage to the grid of the amplifying valve and to adjust the deflection of the triode-voltmeter to a definite scale reading. This adjustment is made by means of a variable shunt across the instrument of the triode voltmeter. The triode voltmeter used is of the bridge type, grid rectification being used.

A complete diagram of connections is given in Fig. 19. The D.C. voltage across the resistance R_1 is chosen to be 100 volts, R_1 being $10^5\ \Omega$.

The range from 0.01 to 5 per cent. is covered by four positions of the switch *SW*.1, the fifth position being for compensation and

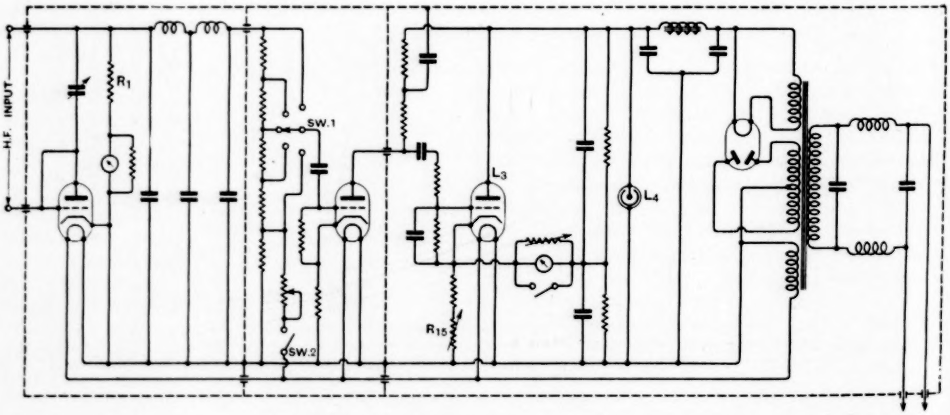


Fig. 19.—*Circuit diagram of the Ripple-meter.*

adjustment, the switch *SW*.2 being used for the application of a known calibration voltage.

A variable resistance R_{15} serves for compensation, the bridge being balanced at zero voltage on the grid of the triode L_3. L_4 is a stabilising Neon lamp. External and internal appearance of the instrument is to be gathered from Fig. 20.

The instrument was directly calibrated by means of introducing known ripple-voltages into a battery-operated oscillator.

The calibration curves are given in Fig. 21. Fig. 22 gives the frequency response of the instrument, showing maximum deviation of ± 2.5 db in the range of 40 to 1,400 cs. This relatively poor response is a result of the well-known difficulty of finding a compromise for exceedingly high attenuation for high-frequency, high-working impedances (small energy) and linear frequency response.

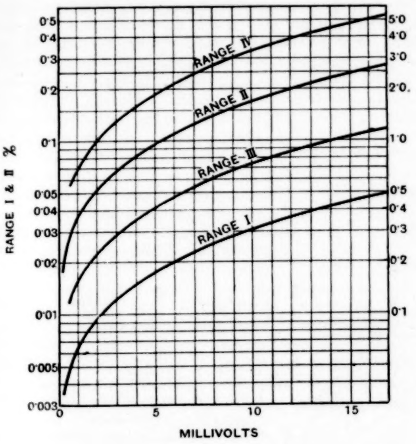


Fig. 21.

LITERATURE ON MODULATION

"Some Studies in Radio-Broadcast Transmission," Ralph Bown, De Loss K. Martin and Ralph K. Potter, *Proc. I.R.E.*, Vol. 14, p. 57, No. 1, Feb., 1926.

"The Use of the Electron Tube Peak Voltmeter for the Measurement of Modulation," C. B. Jolliffe, *Proc. I.R.E.*, Vol. 17, No. 4, p. 660, April, 1929.

"Amplitude, Phase and Frequency Modulation," Hans Rode, *Proc. I.R.E.*, Vol. 19, No. 12, Dec., 1931, p. 2145.

"Frequency Modulation," B. v. d. Pol, *Proc. I.R.E.*, 18 1194, 1930.

"Über Frequenzmodulation," H. Roder, *Telefunken Zeitung*, No. 53, 48, 1929.

"Über Modulation, Senderbandbreite und Demodulation," *Telefunken Zeitung*, No. 55, 28, 1930.

"Note on the Relationships existing between Radio Waves Modulated in Frequency and Amplitude," *Exp. Wireless and Wireless Eng.*, 7, 609, 1930.

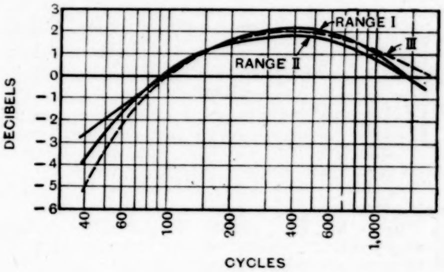


Fig. 22.

"Untersuchungen an Amplituden-und Frequenz-modulierten Sendern," *Elek. Nachr. Techn.*, 7, 488, 1930.

"The Physical Reality of Sidebands," F. M. Colebrook, *Exp. Wireless and Wireless Eng.*, 8, 4, 1930.

"Detection at High Signal Voltages," S. Ballantine, *Proc. I.R.E.*, 17, 1153, 1929.

"Frequency Modulation and Distortion," T. L. Eckersley, *Exp. Wireless and Wireless Eng.*, 7, 482 1930.

"An Interesting Side-band Problem," G. W O. Howe, *Exp. Wireless and Wireless Eng.*, 7, 651, 1930.

"Telephone Transmitter Modulation Measured at the Receiving Station," L. B. Turner, M.A., M.I.E.E., *Exp. Wireless and Wireless Eng.*, Jan., 1927, IV., 3, 1927.

"Telephone Transmitter Modulation Measured at the Receiving Station," Balth. v. d. Pol, D.Sc., and K. Posthumus, E.E., *Exp. Wireless and Wireless Eng.*, IV, 141, 1927, March, 1927.

"The Modulation in Radiotelephony," R. A. Heising, *Proc. I.R.E.*, Dec. 1, 1920.

The Industry

A LEAFLET received from Claude Lyons, Ltd., of 76, Old Hall Street, Liverpool, described an interesting impedance bridge (Type 650A). The instrument gives direct readings of capacity, resistance, and inductance up to 100 mfds., 1 megohm, and 100 henrys respectively.

Marconi's Wireless Telegraph Company, Ltd., of Electra House, Victoria Embankment, London, W.C.2, have just issued a technical pamphlet describing a new series of portable precision frequency meters.

A Philco service station, planned exclusively for installing and repairing car radio receivers, has been opened on the Great West Road.

A pentagrid converter, a high-power pentode, a double diode, and a double rectifier, the latter suitable for voltage-doubling circuits, are among new valves added to the Ostar-Ganz high-voltage series.

Interference to Wireless Communications of the Mercantile Marine

Paper by Commdr. J. A. Slee, C.B.E., R.N., M.I.E.E., read before the Wireless Section I.E.E. on May 4th, 1934

Abstract

THE paper records steps which have recently been taken to analyse the various types of interference to which the wireless communications of the mercantile marine are subjected.

The chief wavelength bands allotted to marine communication are :

110–160 kc., c.w., chiefly private traffic of liners.

285–320 kc., beacon service, ships with d.f. apparatus observing coastal beacons.

365–385 kc., D.F. service, ships transmit on 375 kc. (800 m.), and coast d.f. station communicates bearing.

400–485 kc., general ship-to-shore, and shore-to-ship traffic.

485–515 kc., guard band to distress wave (600 m.), also used for calling, etc.

In the 110–160 kc. band the traffic is revenue-earning, and good apparatus and skilled operation can be expected. Broadcasting stations within or near the edge of the band may interfere with communications. In the paper the author describes the method of analysis that has been used, taking into account the performance curve of a typical liner's receiver and the probable field-strengths of interfering broadcasting stations, based on C.C.I.R. field-strength/distance data curves. A "probable interference curve" is illustrated, showing the interference to be expected at various distances from a stated station on different wavelengths.

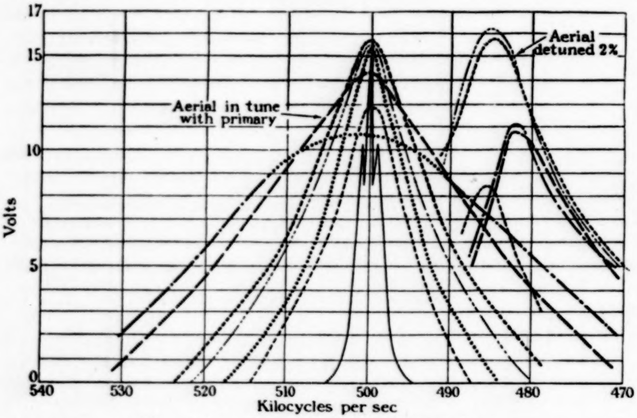


Fig. 7(*a*).—*Emission of spark transmitter.*

— — —	Non-quenching, 10 per cent. coupling.	Aerial amps. :	(tuned) 1.8, (detuned) 1.6.
- - - - -	Non-quenching, 8 per cent. coupling.	Aerial amps. :	(tuned) 1.8, (detuned) 1.6.
▬ ▬ ▬ ▬	Non-quenching, 6 per cent. coupling.	Aerial amps. :	(tuned) 2.2, (detuned) 2.1.
—·—·—	Non-quenching, 4 per cent. coupling.	Aerial amps. :	(tuned) 2.2, (detuned) 2.1.
--------	Non-quenching, 2 per cent. coupling.	Aerial amps. :	(tuned) 1.5, (detuned) 1.0.
· · · · · ·	Q.G.		
———	I.C.W.		

In this band the problem of interference between mobile stations is not very serious. In coast stations conditions are better, because the noise level is lower and directional reception can often be used.

In the 365–515 kc. band the question of interference is much more difficult, as distress working and automatic alarm-signal apparatus have to be considered. Particular care has, therefore, been taken to keep the band 485–515 kc. (containing the 600 m. S O S wavelength) free from any interference. The author describes the method taken to analyse the probable interference in this band from broadcasting stations on adjacent frequencies, and shows a graph of probable interfering fields for European waters at Danzig, Odessa, Venice, Nordderch, and Ushant.

In the same band interference is also caused by other stations taking part in the same service, the main source of trouble being that the vast majority of ships are equipped with spark transmitters. Three investigations have recently been undertaken on this subject : (*a*) the examination of the tuning of the transmitting circuits ; (*b*) the examination of the spectra of various transmitters in the laboratory ; (*c*) the examination of the spectrum by field-strength measuring instruments at a distance. Details are given in the paper of the apparatus and methods employed. Fig. 7(*a*)* illustrates the measured emission of a spark transmitter, while Fig. 7(*b*) shows the emissions as observed with a typical marine receiver. Derived interference curves are illustrated in the paper for various distances. The graphs show an optimum transmitter coupling between 4 and 6 per cent. ; looser couplings imply a serious loss of range, and tighter couplings increase interference without a compensating increase in range.

The paper also considers interference from valve transmitters working off the intended frequency. The author discusses the frequency drift due to : (*a*) slow changes ; (*b*) variations of supply voltage :

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* The author's figure numbers are used.

(*c*) change of aerial capacity, etc. It is concluded that the greatest practical difficulty likely to be experienced in the organisation of marine communications when valve transmitters become general will be that of setting the oscillator exactly to any predetermined frequency. Receivers must also be capable of sufficiently accurate adjustment, and it must be certain that they will not slip from the correct adjustment on account of vibration. The problem of realising the ideal is far more difficult with receivers than transmitters.

The last part of the paper deals at considerable length with the subject of interference with direction-finding. This divides into two sections—interference due to a high noise-level and heterodyne interference. A correct choice of site for the direction-finder will reduce the noise-level to a reasonable figure. In many cases the use of the maximum amplification of which most modern direction-finders are capable may bring the noise-level up to audibility. The operator must choose between maximum amplification and a noisy background, or reduced amplification and a silent background.

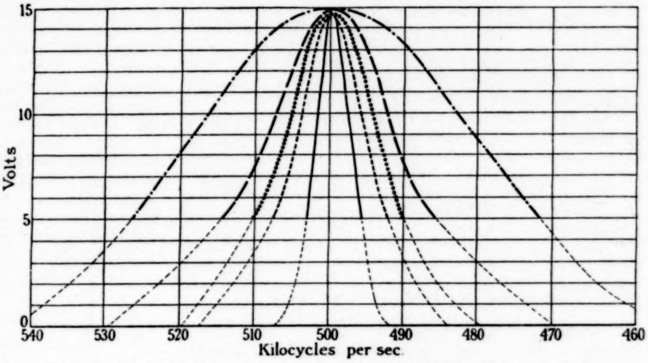


Fig. 7(*b*).—*Emissions as observed with a typical marine receiver. Aerial current the same in all cases.*

▬ ▬ ▬ Non-quenching, 10 per cent. coupling.
━━━ Non-quenching, 5 per cent. coupling.
------ Non-quenching, 2 per cent. coupling.
· · · · · · Q.G.
——— I.C.W.

The effect of heterodyne interference is to cause a considerable reduction in the width of the arc of silence, and if this effect is present at one side of the swing and absent at the other the result will be to distort the bearing. This will cause the beacon to appear more nearly in the same direction as the interfering station than is the fact. The author discusses the interference between beacon stations, and gives a map of north-western European waters showing the regions of interference of different strengths between the stations of the existing beacon system.

Discussion

Mr. W. L. McPherson regretted the absence of short-wave data from the paper and considered this was of increasing importance. On these wavelengths the ship's interference-level was also very important and was already acute on two-way telephony working. He also queried the relative interference values of spark, c.w. and i.c.w. of the same R.M.S. strength.

Mr. M. Reed pointed out that the author had not mentioned the demodulation effect of broadcasting stations. In the 110–160 kc. band he considered two or three h.f. circuits necessary, possibly with additional note tuning.

Mr. F. Woods thought greater prominence should be given to noise level. This was particularly important in direction finding, and he discussed several points of noise-level in relation to the position on deck of the receiving coil.

Dr. W. Rawlinson said the paper was of interest and value to reception at sea generally, He criticised the author's transmitter resonance curves given in the paper.

Mr. E. B. Moullin raised a few queries of detail including the signal strengths necessary at the various frequencies.

Major Binyon referred to the future mechanisation of marine wireless traffic, and suggested the importance of automatic direction-finding operations.

Mr. F. Best added a few points of comment on matters in which he had been connected with the author in the technical detail of the paper.

Mr. Bainbridge-Bell asked for definition of several expressions used in the paper, including references to the different types of emission.

After the author had replied to some of the discussion, the meeting and the session concluded with a vote of thanks to the author, proposed by the chairman, Mr. G. Shearing.

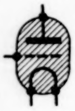
Correspondence

Letters of technical interest are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

Gas-filled Valve Symbols

To the Editor, The Wireless Engineer.

SIR,—With regard to Mr. Maddock's advocacy of a differentiation between the symbols of ordinary thermionic valves and gas-discharge tubes (thyratrons), it appears customary in Germany to shade the symbol for the latter, as shown.



I imagine this is meant to represent the glow of the discharge, but in any case it seems a satisfactory differentiation.

Welwyn Garden City. A. W. CLARKE.

Precision Heterodyne Oscillators

To the Editor, The Wireless Engineer

SIR,—I have read with considerable interest the article in your May issue by Mr. W. H. F. Griffiths covering a very excellent design. My only criticism is of his own criticism of so-called American practice of using a crystal oscillator for the fixed frequency source. So far as I know there is not one commercial instrument of this type available, and in the various laboratories of different companies with whom I have been connected no such instrument was ever found. The only article covering such design appeared in the February 1932 I.R.E. proceedings, by Mr. Lapham of the Bureau of Standards, and while the stability claimed (0.1 cycle) is very good, I do not feel that Mr. Griffiths is justified in assuming that "it is the practice in American heterodyne oscillators." I would also be interested in hearing from the author regarding the allowances which are usually considered necessary when a variable condenser of the type described is used to obtain a smooth variation of log f versus θ. I refer, of course, to the "edge effects" as each additional sector of the rotor approaches and enters the space between the stator plates.

Here in this country the Bell System uses an oscillator of high-frequency stability and satisfactory performance, and it is known as their Type 13-A. This uses two triode oscillators of the resistance feed-back type, one feeding through a low-pass filter into a balanced transformer feeding the grids of two similar triodes used in the familiar balanced modulator arrangement. The other oscillator (variable) signal is introduced across a resistance connected between the secondary (centre point) of the balanced transformer and ground. (Negative bias is provided, of course.) From the modulator plates the audio signal is transformer coupled to two hi-mu tubes which in turn are impedance coupled to the two output tubes of low plate impedance, thence by means of a balanced transformer to the 600 ohm output terminals. Due to the push-pull arrangement and the use of a large variable condenser across the secondary of the balanced modulator input transformer (used for an output control) the harmonic content is very small.

Further, I wish to say that I am in complete accord with the Editorial by Prof. Howe and the letter in the May issue from Mr. Ladner. It is only fair, however, to state that all Americans do not feel the same way as does Mr. Fisher. A good example of this is the paper by Mr. C. B. Aiken, entitled "The *Detection* of two modulated waves." Mr. Aiken also happens to be a member of the Bell Telephone Laboratories, who are, I believe, generally credited with the origination of the misuse of the term demodulation.

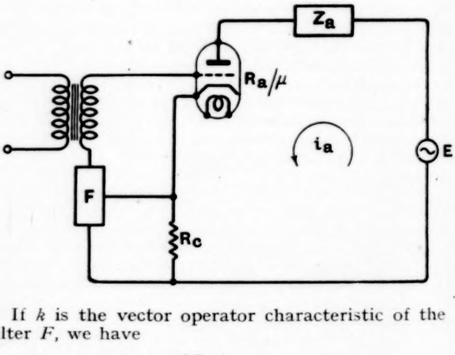
Los Angeles, W. W. LINDSAY, JR.
California.

Decoupling Efficiency

To the Editor, The Wireless Engineer

SIR,—Seldom are we afforded an insight into manufacturers' motives, but in your April issue Mr. Kinross tells us that "on commercial mains receivers the chief object in decoupling the grid circuit of a valve is to avoid any low-frequency component of the imperfectly smoothed D.C. anode current from getting on the grid of the valve and so producing hum."

This being so, it seems a great pity that all such decoupling filters at present in use have a negative efficiency, *i.e.*, the hum level is increased by the inclusion of the filter.



If k is the vector operator characteristic of the filter F, we have

$$e_g = -kR_c i_a$$

$$E + e_g = i_a(Z_a + R_a + R_c).$$

$$\therefore \quad i_a = \frac{E}{Z_a + R_a + R_c(1 + \mu k)}.$$

Bearing in mind that $R_c \doteqdot R_a/\mu$ and (for a pentode) $|Z_a| \ll R_a$, we see that i_a is doubled by the inclusion of a filter which Mr. Kinross would pass as 100 per cent. efficient. In the case of a triode the proportionate increase is less, about 4/3.

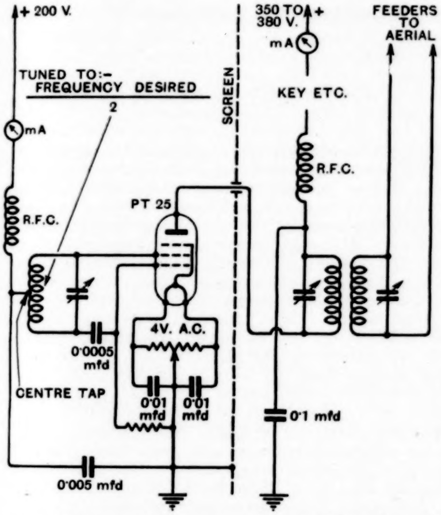
It may be considered that as the legitimate audio currents are also affected, and by equal amounts, the relative hum level is independent of the filter. Harmlessness is no justification for existence.

Handsworth, G. FARREN CLARKE.
Birmingham.

Electron-coupled Transmitters

To the Editor, The Wireless Engineer

SIR,—With reference to Mr. Yeo's letter in your issue of April, 1934, it may be of interest to state that I have been experimenting with electron-coupled transmitters during the past two months. I used in the first instance an old Marconi Pentode type P.T.4, directly heated. This gave about 5 watts input to aerial and was fairly satisfactory in use. It seemed equally as efficient as another 5 watter used in a T.P.T.G. transmitter, with the added advantage of a better note when properly adjusted. A Marconi M.P.T.4 indirectly heated Pentode was then used and this appeared to give better results with a clearer note, reports being "D.C." Quite long distances were spanned, using slightly under 5 watts, reports being received from China, Hong Kong, India, Australia and South Africa. A Marconi P.T.25 was then acquired and with the high tension on hand about 16 watts were available.



A diagram is given of the layout. Using an efficient voltage fed half-wave Hertz aerial on about 7,100 k.c., many distant countries were worked with the P.T.25, including the West coast of U.S.A., Japan, China, Hawaii, India, all parts of Australia, South Africa, and, last but not least, a London amateur. A change was then made to about 14,200 k.c., and although difficulty was anticipated on this shorter wavelength, once the frequency was ascertained and a little fiddling about carried out, the writer was agreeably surprised with the way in which the Pentode performed. Japan was first worked, then contacts were established in turn with Australia (Queensland in all daylight working), Finland, Sweden, Czecho Slovakia, Holland and Germany. All reports were good, varying from QSA3 R3 (the poorest) to QSA5 R6. On one occasion, complaint was made about unsteadiness of the signal, but this, I am convinced, was due to our erratic electric mains. The tone was T8 at times but not consistent.

In conclusion, I must express admiration for the electron-coupled transmitter, and I feel sure that much better results as regards tone would be available with a specially built radio frequency pentode. It will be observed that the writer employed exclusively audio frequency pentodes, simply because no other makes or types were available.

It will be noted that the drive circuit connected between the two grids was in all cases tuned to :—"frequency divided by two," *i.e.*, on 40 metres the drive was tuned to 80, while when transmitting on 20 metres the drive was tuned to 40 metres. No neutralising was found necessary with any of the valves used. J. MACINTOSH.

Kuala Lumpur,
Fed. Malay States.

A New Property of the Ear?

To the Editor, The Wireless Engineer

SIR,—The phenomenon reported by Dr. Vrijdaghs in your April issue has been observed by myself, but was always subconsciously attributed to reaction back on the source. Two common cases, however, in which this is now seen to be impossible, are: the factory testing of MC speakers with 50 h input from the mains—the pitch of the note rises with increased input; the reception of the B.B.C. 1,000 h tuning signal—the pitch decreases as volume is increased.

The explanation based on the increase with amplitude of the elasticity of the aural resonators, as Dr. Beatty observes in your May issue, fails to account for the *rise* in pitch at low frequencies. If, however, we assume the *damping* of the resonators to increase with amplitude, and the efficiency of the resonators, in combination with their input and output couplings, to vary progressively with resonant frequency through zero at the extremities and a maximum in the middle of the aural spectrum, the effect may be adequately explained.

The forced excitation of an infinite series of resonators will, in general, produce maximum response in the resonator whose natural frequency of vibration is equal to the frequency of the applied periodic force, but if the efficiencies of the resonators differ, this does not hold true, and in the case where the efficiency varies progressively with the natural frequency, the maximum response, and the centre of gravity of the curve of responses, will be shifted by an amount which is greater the greater the decrement of the resonators.

If the efficiencies of the resonators are equal, the form of the curve of responses is given by

$$A = \left[1 + \frac{16\pi^2}{\delta^2}\left(\frac{\Delta f}{f}\right)^2\right]^{-\frac{1}{2}} \quad \cdots \quad \cdots \quad (1)$$

which shows a maximum when $\frac{\Delta f}{f} = 0$.

Where the efficiencies vary linearly over the range of resonators affected by the sinusoidal driving force

$$A = \left\{ \frac{1 + m\left(\frac{\triangle f}{f}\right)}{\left[1 + \frac{16\pi^2}{\delta^2}\left(\frac{\triangle f}{f}\right)^2\right]^{\frac{1}{2}}} \right\} \quad \cdots \quad \cdots \quad (2)$$

Then putting

$$\frac{dA'}{d\left(\frac{\triangle f}{f}\right)} = 0.$$

$$\frac{\triangle f}{f} = \frac{m\delta^2}{16\pi^2} \quad \cdots \quad \cdots \quad (3)$$

This fraction represents the normal difference between the natural frequency of the resonator transmitting maximum sensation to the brain, and the frequency of the applied sound wave.

If δ is considered to be small for small amplitudes, then the familiar "threshold of audibility" curve will give a fairly true inverted picture of the relative efficiencies of the aural resonators, and if the maximum value for m, the efficiency constant, is obtained therefrom and substituted in (3), together with the smallest value of δ consistent with the absence of perceptible time lag in the response of the ear to varying sound levels, we find that $\frac{\triangle f}{f}$ is very small (about .001).

(for $m = 3$, $\delta = 0.25$)

At high acoustic levels δ must be assumed to increase tenfold (*i.e.* to 2.5) in order to give pitch deviations corresponding to those experimentally obtained, and at the same time the relative sensitivities between resonators must be maintained.

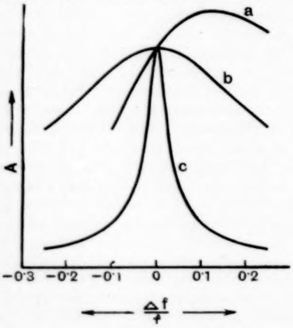


Fig. 1.

The apparent equalisation of sensitivities at high levels is due to this increased damping; we are in effect viewing the spectrum through a broad slit. The large values of apparent differential sensitivity obtained at the extremes of the audio range are due to the same cause.

Fig. 1 shows curves of relative response for the cases

(a) $\delta = 2.5$, $m = 3.0$, (b) $\delta = 2.5$, $m = 0$, (c) $\delta = 0.25$, $m = 0$.

It will be observed that Dr. Vrijdaghs' results show the change of sign to occur at 325 h, whereas the frequency of maximum threshold sensitivity is about 2,500 h. This may be due to the superposition of the effect of variable elasticity mentioned by Dr. Beatty, which will be additive at frequencies greater than 2,500 h, and in opposition in the lower register.

Person *A* in Dr. Vrijdaghs' tabulated results shows a slight anomalism at 1,500 h. It would be interesting to know if this person's threshold of audibility characteristic exhibits a corresponding kink, due to partial deafness, which would result in a reversal of slope over a small portion of the range.

G. FARREN CLARKE.

Handsworth, Birmingham.

Books Received

Elements of Radio Communication

By J. H. Morecroft. 2nd edition. Pp. 286 + xii. Published by J. Wiley and Sons, New York, and Chapman and Hall, 11, Henrietta Street, London, W.C.2. Price 18s. 6d. net.

The first edition of this book appeared five years ago and was intended to serve as an elementary presentation of the material contained in the author's well-known "Principles of Radio Communication." The plan of the book remains unchanged: it is a simple text-book for wireless students in which alternating-current theory is developed with a minimum of mathematics and applied to the practice of radio. It is not a "popular" account, nor is it a book for specialists, but it is admirably adapted to the earnest amateur. The second edition is up to date. New developments, such as very short waves, push-pull operation, multiple valves, automatic volume control, are described, and a collection of worked-out examples serves to clarify the reader's ideas.

R. T. B.

Magnetic Materials at Radio Frequencies

A critical survey of present knowledge, by F. M. Colebrook, B.Sc., D.I.C., A.C.G.I. Special Report No. 14 of The Radio Research Board.

A scientific pamphlet on the behaviour of Magnetic Material with special reference to Iron-Powder cores for coils. Pp. 22. Published by H.M. Stationery Office. Price 6d.

Theory of Radio Communication

Post Office Engineering Department Technical Instructions. Technical instructions prepared primarily for use in connection with Workmen's Correspondence Classes. Pp. 79 with 173 diagrams. Published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 7s. net.

Television To-day and To-morrow

By Sydney A. Moseley and H. J. Barton Chapple, Wh. Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E. (4th edition). Revised and brought up to date with a foreword by John L. Baird. A general account of the history and progress of television, chiefly relating to the Baird system. Pp. 208 + xxxi, with 405 diagrams and illustrations. Published by Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 7s. 6d. net.

Abstracts and References

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PROPAGATION OF WAVES

Ultra-High-Frequency [60 Mc/s] Transmission over Indirect Paths.—G. W. Pickard. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, p. 418 : short summary only.)

"The results of observations of transmission of the order of 60 Mc/s over numerous indirect paths, including the Mount Washington to Blue Hill circuit, were discussed. Large diurnal changes of the order of 60 db were shown to exist and to possess seasonal trend. The probable existence of meteorological correlations associated with surface temperature gradients and inversions was also discussed. Field-intensity observations over water paths from Seabrook Beach, N.H., to Cape Neddick were covered."

Rain may interfere with Ultra-Short-Wave Radio [Fog and Rain will prevent Development of Reliable War-Time or Commercial Use of Micro-Waves below 10 cm].—Potapenko. (*Sci. News Letter*, 19th May, 1934, Vol. 25, No. 684, p. 312.)

Radio Exploration of the Ionosphere.—E. V. Appleton. (*Nature*, 26th May, 1934, Vol. 133, p. 793.)

The intensity of the earth's magnetic field at ionospheric levels may be estimated by measurements of the critical penetration frequencies f_e and f_o for the extraordinary and ordinary waves respectively. For conditions of quasi-transverse propagation, Appleton and Builder (1933 Abstracts, p. 262) have shown that H, the total magnetic intensity, is related to f_e and f_o by the equation $H = (2\pi m/e) \, . \, (f_e^2 - f_o^2)/f_e$, where e, m = charge and mass of electron respectively. From a first series of 200 measurements the average value of H calculated from this formula is found to be 0.42 gauss, compared with a value at the ground of 0.467 gauss. The theoretical values for heights of 200 and 300 km, obtained by representing the earth's magnetic intensity above the surface by the formula $H_0(1 - 3h/R)$ (H_0 ground value, h elevation, R earth's radius), are 0.42 and 0.40 respectively, which agree well with the value obtained by radio methods.

A new method of ionospheric investigation is the production of a frequency change on a pulse emitter; this is equivalent to using an extremely brief pulse and permits echoes to be investigated which are normally unresolved. By this means a difference in equivalent height for the two magneto-ionic components of 3.75 km has been measured, and differences of 1 km or less can be detected.

The Appleton-Hartree Formula and Dispersion Curves for the Propagation of Electromagnetic Waves through an Ionised Medium in the Presence of an External Magnetic Field. Part 2: Curves with Collisional Friction.—Mary Taylor. (*Proc. Phys. Soc.*, 1st May, 1934, Vol. 46, Part 3, No. 254, pp. 408–435.)

Part 1 dealt with the dispersion curves obtained in the absence of friction (1933 Abstracts, p. 263). Part 2 deals with the effect of friction on the curves. Calculated curves are given for four typical wavelengths, 80, 240, 400 and 1 000 m, for collisional frequencies of 10^5, 10^6, 10^7 c/s, which usefully represent the various stages in the effect of increasing friction. The two outstanding phenomena of magneto-ionic propagation in the presence of collisional friction are (1) greater attenuation and absorption (in general) of the right-handed component (for values of the magnetic field appropriate for down-coming waves in the northern hemisphere), (2) transition from quasi-transverse to quasi-longitudinal propagation at a certain critical collision frequency; these are illustrated by the curves. "The use of the dispersion curves in the interpretation of propagation phenomena is discussed; consideration of the values of the indices of attenuation in addition to those of the indices of refraction leads to the general conclusion that the lower boundary of the Kennelly-Heaviside layer must be sharp in the optical sense and that reflection of long waves occurs at this boundary at the same height, in general, as that of much shorter waves."

On the Interest of Continuous Investigations of the Ionosphere by the Method of Radio Echoes [Possible Verification of Hypothesis of Deformation of Ionosphere under Pressure of Solar Radiation, producing Hollow Cylindrical Cometary Tail bound to the Earth].—A. Dauvillier. (*U.R.S.I. Paper A.G.* 1934/No. 1, Comm.II, 5th General Assembly.)

The hypothesis, which would explain the diurnal variation of polar and other auroras, could be tested by the continuous recording, over a whole year and at various latitudes, of the height of the upper conductive layers of the ionosphere; this, by the tracing of a static polar diagram in the equatorial plane and in various parallels, would determine the form of the reflecting ellipsoids. For other recent papers by Dauvillier *see* Abstracts, 1932, pp. 159, 218, 337, 633; March, p. 146 and back references; and May, p. 261, r-h column.

Recent Studies of the Ionosphere [since June, 1933: E, F and F_2 Layers refract, and E, F_2 and "G" (700–800 km) also reflect: etc.].—S. S. Kirby and E. B. Judson. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 548–549: short summary only.)

"The most prominent layer returning waves by reflection is the one which has been called the abnormal E layer; it is probably identical with the regular E layer, but because of the steep ion gradient which forms at times it serves to reflect the radio waves rather than to refract them. Radio waves at normal incidence may be reflected from a layer of given ion density at much higher frequencies than they can be refracted . . . No critical frequencies are observed from the reflecting E layer; reflections gradually weaken and disappear as the frequency is increased. No correlation of the appearance of abnormal E layer and thunderstorms has been found. The F_2 and G layers exhibit some of these phenomena at frequencies above the F_2 critical frequency."

Some Recent Studies of the Ionisation of the Ionosphere [Fifth Pacific Science Congress Paper].—J. P. Schafer and W. M. Goodall. (*Hochf:tech. u. Elek:akus.*, April, 1934, Vol. 43, No. 4, pp. 137–139.) Summary, by Zenneck, of the full paper. For preliminary communications *see* February Abstracts, p. 85.

Studies of the Ionosphere and Their Application to Radio Transmission [Historical Survey: Pulse-Method Measurements 1930/1933: 46 Literature References].—S. S. Kirby, L. V. Berkner, and D. M. Stuart. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 481–521.) *See* April Abstracts, p. 199.

On a Theoretical Discussion of the Distribution of Ozone in the Atmosphere and the "Umkehreffekt" [Inversion Effect].—J. Gauzit: Pekeris. (*Comptes Rendus*, 14th May, 1934, Vol. 198, No. 20, pp. 1800–1802.)

Götz' "inversion" effect is that if I and I' are the intensities of two radiations, of wavelength λ and λ', diffused by the sky at the zenith, λ being strongly and λ' only slightly absorbed by the ozone, the quantity $\log I/I'$ varies with the elevation of the sun and passes generally through a minimum for an angle of about 5°. This effect has been interpreted by supposing that, as the sun approaches the horizon, a considerable fraction of the light is diffused by the very high atmosphere, either within and above an extended distribution of ozone (Chalonge) or above a simple layer (Götz): under either hypothesis the numerical calculations show the possibility of the "inversion" effect. Recently Pekeris claims to have proved that, whatever the ozone distribution may be, neither the primary nor the secondary diffusion can explain the effect. The present writer refutes his arguments and defends the results of Götz.

Simultaneous Measurements of Ozone near the Ground at the Jungfraujoch and in Lauterbrunnen [Preliminary Note: Results of 12 Days' Observations in August, 1933].—D. Chalonge, F. W. P. Götz and E. Vassy. (*Physik. Zeitschr.*, 11th May, 1934, Vol. 22, No. 19, p. 297.) For a *Comptes Rendus* Note *see* June Abstracts, p. 315, l-h column.

Study of the Solar Spectrum in the Far Infra-Red [and the Absorption Bands due to Water Vapour and Ozone].—J. Devaux. (*Comptes Rendus*, 30th April, 1934, Vol. 198, No. 18, pp. 1595–1596.)

Registrierungen und Vergleichsmessungen ultravioletter Sonnen- und Himmelsstrahlung mit kugelförmigen Kadmiumzellen (Registration and Comparative Measurements of Solar and Sky Radiation with Spherical Cadmium Cells [Technique of Construction and Use of Cells: Comparison of Various Types]).—M. Bender and F. Krüger. (*Physik. Zeitschr.*, 15th April, 1934, Vol. 35, No. 8, pp. 321–328.)

Influence of the [Solar] Eclipse upon Radio Transmission Phenomena [Observations on 3 800 kc/s].—T. Nakai. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, p. 241: in Japanese, with signal strength curves.)

Voortplanting des Nachts van Golven van 150–2 000 kc/s (2 000–150 meter) over Afstanden van 50–5 000 km (Night Propagation of Waves of Frequency 150–2 000 kc/s (2 000–150 m) at Distances of 50–5 000 km).—B. van der Pol. (*Tijdschr. Nederland. Radiogenoot.*, April, 1934, Vol. 6, No. 4, pp. 73–77.)

Cf. 1933 Abstracts, pp. 319, 382, 439, 518, 560 (references to reports of van der Pol's Committee at the Madrid Conference, 1932). The present note, signed by the members of the Committee, finds that the Committee's conclusions as to night propagation have been justified by measurement. The graphs for daylight are to be regarded as referring to direct [ground] radiation, for the middle of a summer's day. At other times the measured values lie between these day and the night values. Some indirect radiation is generally present during the day.

Reports on various measurements, of which a list is given, have been received by the Committee. A diagram is given, deduced from these reports, showing the quasi-maximum and the mean (probable) values of the nocturnal field strength for the frequency and distance ranges mentioned in the title, over land and sea, for 1 kilowatt of radiated power.

SEASONAL VARIATIONS OF SIGNAL INTENSITY AND THE FADING PHENOMENA OF SOME [Japanese Medium-Wave] BROADCASTING STATIONS.—M. Kinase and S. Ueno. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. 217–227.)

The following conclusions are drawn: (1) the monthly average of day field intensity has a tendency to become maximum in summer and winter, and minimum in spring; (2) the propagation of JONK is relatively poor, while that of JOHK is much more satisfactory [as regards the fading of NK, "it is not clear whether this is due to the mountains in its path or whether it is due to its situation in a particular region where fading phenomena are prevalent"]; (3) a station of stronger day field intensity is subject to less fading than one of lower intensity; (4) fading of smaller amplitudes occurs equally for all values of day field intensity at night, while that of large amplitudes occurs more frequently as the day field becomes lower; and (5) fading of both slow and rapid period decreases with increasing day field intensity.

FIELD STRENGTH MEASUREMENTS AND DIRECTIONAL OBSERVATIONS OF HIGH-FREQUENCY [Short] RADIO WAVES AT THE ELECTROTECHNICAL LABORATORY, MINISTRY OF COMMUNICATIONS —III.—T. Nakai. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. F-53–F-91.) For previous parts *see* January Abstracts, p. 41.

ON DIRECTIONAL OBSERVATION OF LONG-DISTANCE SHORT-WAVE STATIONS AND THE RELATION BETWEEN DIRECTIONAL DEVIATION AND SCATTERING IN THE IONOSPHERE.—Nakai. (*See* under "Directional Wireless.")

ON THE TRANSMISSION OF SHORT WAVES THROUGH THE NORTH-POLAR NIGHT ZONE.—Nakai and Nakagami. (*See* under "Directional Wireless.")

NORTH ATLANTIC SHIP-SHORE RADIOTELEPHONE TRANSMISSION DURING 1932/1933.—C. N. Anderson. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 545: short summary only.)

"A comparison is made with the data obtained during 1930 and 1931 [1933 Abstracts, p. 206]. In general, transmission during 1932/1933 tends to be somewhat better on frequencies below about 9 Mc/s and somewhat poorer on frequencies above 9 Mc/s. At 4 Mc/s the increase is of the order of 10 db and for 13 and 17 Mc/s the decreases are about 6 and 10 db, respectively."

SUR L'INTERFERENCE DES ONDES RADIOÉLECTRIQUES COURTES DANS LE CAS DE SUPERPROPAGATION (The Interference of Short Radio Waves in the Case of Propagation along the Longer Great-Circle Arc [in Longitude Determinations: Saïgon/Paris Records: the Effect of Phase Differences on the Recorded Signal Shapes: Simultaneous Recording at Two Different Receiver Positions]).—N. Stoyko. (*Comptes Rendus*, 30th April, 1934, Vol. 198, No. 18, pp. 1589–1591.)

APPARENT VELOCITY OF PROPAGATION OF ELECTROMAGNETIC WAVES.—H. C. Freiesleben. (*Naturwiss.*, 11th May, 1934, Vol. 22, No. 19, pp. 302–303.)

A note summarising recent work on the observation of time signals and the apparent velocities of long and short waves deducible therefrom: *cf.* Stoyko and Jouaust, 1933 Abstracts, p. 437 (two).

THE VELOCITY OF STAR LIGHT [and the Question of a 4 km/sec. Decrease per Year].—Salet: de Bray. (*Science*, 11th May, 1934, Vol. 79, No. 2054, Supp. p. 9.) *See* also Abstracts, 1929, p. 443, and 1932, p. 576, r-h column.

PROPAGATION OF HIGH-FREQUENCY CURRENTS IN GROUND RETURN CIRCUITS.—Wise. (*See* under "Aerials and Aerial Systems.")

ABSORPTION MEASUREMENTS IN LIQUIDS IN THE REGION OF SHORT ELECTRIC WAVES. II.—Malsch. (*See* under "Measurements and Standards.")

ON THE CONNECTION BETWEEN THE MOTION OF ELECTRICAL CHARGES AND THE PROPAGATION OF WAVES.—F. Prunier. (*Rev. Gén. de l'Élec.*, 28th April, 1934, Vol. 35, No. 17, pp. 559–566.) Continuing the work referred to in 1933 Abstracts, p. 639 (three).

A GRAPHICAL METHOD FOR OBTAINING THE OPTICAL CONSTANTS OF A MEDIUM [with Smooth Surface] FROM THE REFLECTING POWERS AT SEVERAL ANGLES OF INCIDENCE.—R. Tousey. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 562: abstract only.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

LES PARASITES ATMOSPHÉRIQUES POLAIRES (Polar Atmospherics [Polar Year Records at the Ile des Ours, Tromsö, and Jablonna, Poland]).—J. Lugeon. (*Comptes Rendus*, 7th May, 1934, Vol. 198, No. 19, pp. 1712–1714.)

"The fundamental laws of the propagation of atmospherics thus hold good in the polar circle: long range at night, short range by day, with progressive increase after 'sunset' (beginning of polar night) and rapid diminution at 'sunrise' (beginning of polar day)." For a great part of the year the curves at Jablonna and the Ile des Ours are dissimilar, showing that (neglecting twilight propagation effects) the range is often less than half the 2 460 km separating these points. The daily summer maxima are more intense in the polar circle than in Europe, even without storms in the North. "This unexpected fact is explained by the quasi-permanence, during the polar day, of a source of local atmospherics produced by intense convection currents due to the difference of temperature between the air and the Arctic Ocean. The range of these polar atmospherics seldom exceeds half of the distance Ile-des-Ours/Tromsö, 763 km." The Note concludes by pointing out how the November/March curves support the theory of "sounding in latitude and longitude": *see* Abstracts, 1930, pp. 331, 502–503, and 563–564: *also* 1931, pp. 29 (two), 318, 492, 493–494; and 1933, p. 92.

Investigation of the Frequency Dependence of Atmospheric Disturbances.—M. Kuros. (*Thesis*, Berlin, 1934: at Patent Office Library, London.)

Height of the Aurora in Canada.—T. Alty and F. J. Wilson. (*Nature*, 5th May, 1934, Vol. 133, pp. 687–688.)

This letter gives a preliminary account of measurements of the height of the aurora made at Saskatoon during the winter of 1932/33 (part of the Canadian Polar Year observations). The most frequent lower limit of the auroral arcs was 105 km, in agreement with the value found by Norwegian observers. A height of only 60 km was twice found for the lower limit. Thirty-seven other occasions gave heights of less than 80 km. Long ray structures in the aurora were also observed. In Western Canada the lower limit of the auroral displays seems to be nearer the earth's surface than in Norway.

Some Studies on the Antenna-Earth Current [and the Effects of Different Types of Cloud, Different Relative Humidity, etc.].—H. Noto. (*Jap. Journ. of Phys.*, 28th Feb. 1934, Vol. 9, No. 1, Abstracts pp. 30–31 and 31.) *See* also March Abstracts, p. 145, l-h column.

Esperienze sulla Captazione della Elettricita' atmosferica (Experiments on the Collecting of Atmospheric Electricity [Point Collector 35 m above 0.04 μF condenser: Electrolytic Rectifiers to use Current for Accumulator Charging: etc.].—R. Parodi. (*L'Elettrotec.*, 15th April, 1934, Vol. 21, No. 11, pp. 244–245.)

Lightning Disturbances on Medium-Voltage Networks according to Statistical Information.—D. Müller-Hillebrand. (*E.T.Z.*, 8th March, 1934, Vol. 55, No. 10, pp. 243–246: final part of a series.)

Lightning Computations for Transmission Lines with Overhead Ground Wires [including Calculations of Lightning Flash Impedances].—C. A. Jordan. (*Gen. Elec. Review*, April, 1934, Vol. 37, No. 4, pp. 180–186: Part II of a series.)

Lightning Measurements of the Years 1932 and 1933 in Switzerland.—K. Berger. (*Bull. Assoc. suisse des Élec.*, No. 9, Vol. 25, 1934, pp. 213–229.)

The Calculation of Circuits containing Thyrite [for Lightning Protection, across Contacts to prevent Sparking, Voltage or Current Regulation, etc.].—T. Brownlee. (*Gen. Elec. Review*, April and May, 1934, Vol. 37, Nos. 4 and 5, pp. 175–179 and 218–223.) For McEachron's papers on thyrite *see* Abstracts, 1930, p. 450, and 1931, p. 320.

The Anomalies of the Vertical Component of the Terrestrial Magnetic Field in the Vosges [and Their Relation to Geological Formations].—C. L. Alexanian. (*Comptes Rendus*, 7th May, 1934, Vol. 198, No. 19, pp. 1715–1717.)

High Cloud Potentials [South African Measurements].—B. F. J. Schonland. (*Electrician*, 25th May, 1934, Vol. 112, No. 2921, p. 682.)

"Measurements indicated the existence of cloud potentials higher than 25 400 v to the inch, or more than 1 500 000 000 v per mile. As a rule the pressure is dissipated before it attains such high values, although in the case of thunderbolts estimated potentials of 1 000 000 000 v may exist. It was ascertained that these large potentials are built-up by the splitting of drops of water in the cloud. Large drops from the positive top of the cloud fall by gravity to a lower level where small negative drops are discharged." This accounts for 9/10ths of the discharge, the negative charge from the base of the cloud to earth accounting for the remaining 1/10th.

Penetrating Rays from Thunderclouds [thrown Upwards from the Cloud and then drawn down to Earth].—B. F. J. Schonland. (*Science*, 4th May, 1934, Vol. 79, No. 2053, Supp. p. 6: *Sci. News Letter*, 12th May, 1934, Vol. 25, No. 683, p. 292.)

Investigations on penetrating radiations, resembling "soft" cosmic rays, which are thrown upwards from the tops of thunderstorm clouds. They are drawn down to earth, always to the east of the cloud, by the earth's magnetic field.

On the Constitution of the Cosmic Rays [Reconciliation of Conflicting Facts by a New Hypothesis based on Joliot's Work on Nuclear Absorption with Formation of Electrons and Positrons].—A. Piccard: Joliot. (*Comptes Rendus*, 7th May, 1934, Vol. 198, No. 19, pp. 1683–1685.)

Cosmic-Ray Ionisation at High Altitudes.—A. H. Compton and R. J. Stephenson. (*Phys. Review*, 1st April, 1934, Series 2, Vol. 45, No. 7, pp. 441–450.)

The writers find a theoretical criterion for interpretation of the ionisation/pressure relation as due to (*a*) particles with a finite range or (*b*) photons, and find that comparison with experimental results shows that the criterion for particles with a finite range is satisfied through the altitude range from 40 to 15 cm Hg. Rays of two distinct range groups are found to be present, one due to electrically charged rays of great energy which may be protons or positrons, and one, confined to the upper atmosphere, which represents rays unaffected by the earth's magnetic field. It is found that photons cannot constitute more than a negligible part of primary cosmic rays.

Investigations on Highly Filtered Cosmic Radiation [Very Hard Rays penetrating 600 m Water form 1% of Total Cosmic Radiation at Earth's Surface].—W. Kolhörster. (*Zeitschr. f. Physik*, 1934, Vol. 88, No. 7/8, pp. 536–549.)

Deflection of Cosmic-Ray Secondaries in Magnetised Iron [Magnetic Induction is Fundamental Vector causing Deflection].—W. F. G. Swann and W. E. Danforth, Jr. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 565: abstract only.)

Cosmic-Ray Ionisation in a Heavy Walled Chamber at High Altitudes.—A. H. Compton and R. J. Stephenson. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 564 : abstract only.)

The ionisation found experimentally up to a barometric pressure of 50.5 mm may be represented by that due to ionising particles with a definite range having a Maxwellian distribution of energies.

The Nature of Statistical Fluctuations [Application to Results of Cosmic Ray Ionisation Experiments].—R. D. Evans. (*Phys. Review*, 15th Jan. 1934, Series 2, Vol. 45, No. 2, p. 137 : abstract only.)

Incipient Arcs in Ionisation Chambers [Cosmic-Ray Bursts Not Merely Due to Instrumental Accidents].—R. D. Bennett. (*Phys. Review*, 1st April, 1934, Series 2, Vol. 45, No. 7, pp. 491–492.)

The Influence of the Ionisation Chamber on the Form of the Cosmic-Ray Depth-Ionisation Curve [Theoretical Paper].—C. Eckart. (*Phys. Review*, 1st April, 1934, Series 2, Vol. 45, No. 7, pp. 451–453.)

PROPERTIES OF CIRCUITS

Het Opwekken van sinusoidale Trillingen met een Trillingstijd, bepaald door een Relaxatietijd (Production of Sinusoidal Oscillations with an Oscillation Time [of Period 15–30 Mins.] determined by Relaxation Oscillations).—J. van der Mark and B. van der Pol. (*Tijdschr. Nederland. Radiogenoot.*, April, 1934, Vol. 6, No. 4, pp. 79–90.)

From the authors' summary :—The present note concerns a retroactive resistance-capacity coupled triode amplifier, consisting of *three* (or more) instead of the usual *two* stages as in the multivibrator. Analysis and experiment show that such a three-stage circuit also produces oscillations, whose wave-form is however very nearly sinusoidal over a wide reaction range, the time period being determined by a relaxation time. Sinusoidal oscillations of period 15–30 mins. may be produced and the system may take a day to reach the final steady state, while it may also be made to generate oscillations of the usual radio frequencies . . . . It was found possible to construct a sharply tunable radio receiver without any inductance coils whatever. A full analysis, both linear and non-linear, of the system is given ; oscillograms are also shown and the relation of the system to one producing relaxation oscillations is pointed out.

On the Different Possible Types of Electrical Oscillation.—J. Mercier. (*Journ. de Phys. et le Rad.*, March, 1934, Series 7, Vol. 5, No. 3, pp. 126–131.) For a *Comptes Rendus* Note on this work *see* May Abstracts, pp. 264–265.

Multiplication of a Frequency by Simple Fractional Numbers.—G. Longo. (*L'Onde Élec.*, February, 1934, Vol. 13, No. 146, pp. 97–100.)

Assuming that the given frequency is f and that a second frequency f_1 is available which is, for instance, equal to $2f/3$, the writer applies these simultaneously to a two-grid detector valve and thus obtains an anode current containing the frequency $f - f_1 = f/3$: this frequency is isolated and applied to a frequency-doubling triode, from whose anode current the doubled frequency $2f/3$ can be separated out and used to excite the first valve. Thus a stable self-maintained system is obtained giving oscillations of frequency $f/3$ and $2f/3$. If, instead of the second valve being a frequency-doubler, it is a detector like the first valve, a stable self-maintaining system giving the half-sum and half-difference frequencies can be obtained by a double process of heterodyning : then if only one frequency f is available, a separate doubling process will give $2f$ and the double heterodyning will then yield $3f/2$ and $f/2$. A second application of the half-sum half-difference process, using the frequencies f and $f/2$, gives $3f/4$ and $f/4$. Thus with a limited number of systems, each of two valves (and on occasion a separate frequency-doubling circuit), a frequency bearing practically any desired ratio to f can be obtained.

A Method for the Solution of Oscillation Problems by Matrices.—Duncan and Collar. (*See* under "Miscellaneous.")

Attenuatori e Correttori (Attenuators and Correcting Circuits [Simple Method of Calculation]).—P. A. Rappis. (*Rassegna d. Poste, Teleg. e Telef.*, July, 1933, Vol. 11.)

The writer divides attenuators into three classes : (1) simple, with equal input and output impedances, and attenuation constant for all frequencies ; (2) matching, with unequal input and output impedances, both constant for all frequencies : serving in the first place to accommodate two circuits of differing impedance and in the second place to introduce a required attenuation ; and (3) equalising or correcting attenuators, with equal input and output impedances, constant for all frequencies, and an attenuation varying according to frequency. Since (1) is only a special case of (2) he treats the latter first, taking a single T stage of input and output impedances Z_1 and Z_2, series resistances r_1 and r_2, and shunt resistance ρ. Then if a is the ratio input-current/output-current, that is, the attenuation, he obtains $r_2 = (a - 1)\rho - Z_2$, $r_1 = Z_1 - (1 - 1/a)\rho$, and $\rho = 2Z_1Z_2/(aZ_1 - Z_2/a)$; from these he derives conditions D and E for the minimum possible attenuation, for $Z_1 > Z_2$ and $Z_1 < Z_2$ respectively. For case (1) he puts $Z_1 = Z_2$ and obtains correspondingly simplified results.

Coming now to the more complex case (3), where the attenuation has to vary from zero to a maximum, according to the frequency, the writer uses the formulae already obtained, together with the telephonic equation for a line with uniformly distributed constants, to obtain an expression which is the vectorial sum of a real quantity (M) corresponding to the attenuation, and an imaginary quantity (N) representing the phase angle of the corrector. Resolving (M) to obtain b (where $b = 2r/\omega\lambda_1 = \omega\lambda_2/\rho$, λ_1 and λ_2 being the reactances of the series and shunt circuits respectively) he obtains $b = \sqrt{2Za/\rho/(a^2 - 1)} - 1$. From this, in order to obtain a given attenuation at a given frequency, the value of b corresponding to that frequency is found and substituted in (N). Now (N) is $2Zba/\rho$, so that this substitution at once gives the relation between resistance and reactance for the required attenuation at the given frequency. Special cases of class (3) are tabulated at the end of the paper, namely high-pass, low-pass, band-pass and high-and-low-pass types. The writer points out that the solutions are based on the supposition that the reactances contain no current components in phase with the potentials. This is not true in practice, but the approximation is good enough.

The Sending End Impedance of Four-Terminal Transmitting Networks [T, Pi, Inverted L and Lattice Types: etc.].—Z. Kamayachi and others. (*Rep. of Rad. Res. in Japan*, December, 1934, Vol. 3, No. 3, Abstracts pp. 22–23.)

Die Klassen realisierbarer symmetrischer T- und Π- Siebschaltungen (The Classes of Practically Useful Symmetrical T and Π Filter Circuits [derived from Their Equivalent Cauer Bridge-Filter Circuits for Cases where the Latter are Less Suitable]).—E. Grünwald: Cauer. (*E.N.T.*, March, 1934, Vol. 11, No. 3, pp. 93–98.)

The Properties of Counter-Retroaction Circuits [Stabilised Feed-Back Amplifier Circuits].—Bernamont and Lévy: Black. (*See* under "Acoustics and Audio-frequencies.")

A Paradoxical Effect of Electromagnetic Induction [Failure of Definition of Induced E.M.F. as Function of the Flux Cut: Induction possible in a Part of the Field where Magnetic Vector is and remains Zero].—J. B. Pomey: Bellini. (*Rev. Gén. de l'Élec.*, 5th May, 1934, Vol. 35, No. 18, pp. 605–608.)

TRANSMISSION

Some Notes on the Standing-Wave [Ultra-Short-Wave] Oscillator.—S. Nakamura and others. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, p. 238: in Japanese.) Experimental results with the oscillator circuit referred to in June Abstracts, p. 340, r-h column (Mouromtseff).

On [Ultra-Short-Wave] Oscillation of Triodes by B-Type Oscillator Method.—S. Ohtaka and others. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, p. 237: in Japanese, with diagram and tables.)

An Electronic [Micro-Wave] Oscillator with Plane Electrodes [and "Backing Plate": giving Wavelengths down to below 10 cm].—Thompson and Zottu. (*See* under "Valves and Thermionics.")

A Suitable Triode for Generating Electron Oscillations [Micro-Waves, by Brake-Field Method].—Kamio. (*See* under "Valves and Thermionics.")

Development of [Micro-Wave] Transmitters for Frequencies above 300 Megacycles.—N. E. Lindenblad. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 549–550: short summary only.)

"With these illustrations [Barkhausen and magnetron circuits] as a background, the author describes a new method of frequency multiplication at very high frequencies. This method yields much greater power outputs than hitherto possible and promises to become very useful." Frequency stabilisation, amplitude- and frequency-modulation, aerials and feeders, and propagation are to be included in the subjects dealt with in the paper.

Transmission and Reception of Centimetre [Micro-] Waves [Split-Anode Magnetron giving 2.5 w at 10 cm, with Efficiency of 12% compared with D.C. Anode Dissipation: Modulation by Variation in Transmission of Ionised Gas: Two Detectors, one almost Aperiodic as regards Frequency Response, the other Electron-tuned].—I. Wolff, E. G. Linder, and R. A. Braden. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 555: short summary only.)

High Q Tank Circuits for Ultra-High Frequencies [$Q = \sqrt{L/R^2C}$: Copper "Hats," with Opposed Wide Brims (Adjustable Gap) mounted on Copper Tube: giving Values of Q of Order of 1 000 to 3 000].—F. A. Kolster. (*QST*, May, 1934, Vol. 18, No. 5, pp. 69–70: *see* also *Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 419–420.)

On the Different Possible Types of Electrical Oscillation.—Mercier. (*See* under "Properties of Circuits.")

New Method of Amplifying and Producing Oscillations of Low Frequency [between 2 and 15 000 c/s: Current 0.5 to 1 Ampere: by Action of Magnetic Fields on Concentric-Cylindrical Crookes' Space, Negative Glow and Faraday Space].—Th. V. Jonescu and I. Cerkez. (*Comptes Rendus*, 23rd April, 1934, Vol. 198, No. 17, pp. 1482–1484.)

Concentric cylindrical aluminium electrodes were used, in hydrogen at 0.4 mm pressure; 500–600 volts d.c. were applied. The tube enclosing the electrodes was inserted in a coil forming part of the oscillatory circuit, and this coil was placed inside a second coil supplied with d.c. of adjustable value.

Production of Sinusoidal Oscillations with an Oscillation Time determined by Relaxation Oscillations.—van der Mark and van der Pol. (*See* under "Properties of Circuits.")

Über die Ausbreitung der Gleichwellensender (Propagation from Common-Wave Transmitters).—P. R. Arendt: Lorenz Company. (*Hochf:tech. u. Elek:akus.*, April, 1934, Vol. 43, No. 4, pp. 124–130.)

It is now generally recognised that good reception on common-wave broadcasting with different programmes is only possible when the field-strength of the stronger station is at least 100 times that of the weaker. The writer therefore deals only with common-wave transmission of the same programme. He quotes the results of Gillett (Abstracts, 1932, p. 111, r-h col.) and Aiken (1931, p. 208) as evidence that satisfactory common-wave transmission is impossible with independent stations merely stabilised (*e.g.* by quartz control) to the same wavelength. The rest of the paper deals with the Lorenz Company's common-wave station network in Germany, in which the various stations in each group are controlled through a long-distance cable. Fig. 7 shows a beat-note, of about 6 minutes' period, measured on two stations of this network: it corresponds to relative agreement within about 2.8×10^{-9}, but at other times beat periods of 15 and even 45 minutes have been recorded (the latter representing a departure of only 3×10^{-10}).

With this new high level of synchronisation (of the order of 10^{-9}) prolonged observations have shown that the zone of bad reception is reduced till it corresponds to a field-strength ratio of 1 : 2. Section III (pp. 128–129) deals with the calculated extent of this zone, by day and by night, on the basis of this ratio and of the Madrid Committee's propagation curves ($\lambda = 200$ m). The character of the interference in the zone is different from that formerly observed: there is neither interference note nor tremolo, only a rhythmic increase and decrease of strength resembling fading. Section IV deals with modulation distortion, and it is shown that the same 1 : 2 ratio gives good reception provided the degree of modulation does not exceed 50%. The final section deals briefly with the method employing independent transmitters corrected at intervals by a synchronising signal by radio or by line.

Synchronisation of Independent Common-Wave Transmitters by Phase-Sensitive Devices working on Subharmonics of Local and Control-Station Waves.—Telefunken: Runge and Pohontsch. (German Pat. 589 832, pub. 15.12.1933: *Hochf:tech. u. Elek:akus.*, April, 1934, Vol. 43, No. 4, pp. 141–142.) *See* also 1933 Abstracts, pp. 285–286.

High Quality Radio Broadcast Transmission and Reception. Part I [chiefly Transmission].—S. Ballantine. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 564–629.)

"What is an acceptable and economically realisable standard of performance for a high quality broadcast system? and what are the weaknesses of the present system and what remedies can be applied to bring its performance up to this standard?" Among the conclusions reached are: (1) serious frequency distortion is produced by the majority of microphones in present-day use: dynamic microphones should be "equalised": the newer types—crystal and ribbon—are satisfactory. (2) The frequency range of a large majority of network programmes is limited to 5 500–6 000 cycles by wire lines: although the A.T. and T. has laid down a network capable of 8 000-cycle transmission, these facilities are seldom employed, principally because the performance of present radio receivers has not seemed to justify the higher cost. (3) Older types of speech input equipment fall off around 5 000 cycles. Older types of radio transmitters also fall off at the higher audio frequencies, but in general at a lower rate. (4) The most prominent source of non-linear distortion is in non-linearity of the modulation characteristic of the radio transmitter and over-modulation caused by operating at too high a volume level. (5) Microphone placement and reverberation control could be improved: this work should be carried out with high quality loud speakers for monitoring and audition purposes.

High-fidelity reception will be dealt with in Part II, but some principal conclusions regarding the receiving system are given on pp. 570–573.

High-Fidelity Monitoring [and the Need for it: Variation in Quality between Equally Well-Equipped Stations, and between Different Programmes of Same Station: a 30–14 000 c/s Monitor].—J. P. Taylor. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 32–34.)

"Favourite theory of broadcast engineering: that transmitter standards should be kept several years ahead of receiver development. Favourite delusion: that they are." *See* also three abstracts, June, p. 320, l-h col., and Ballantine, above.

The Measurement of Harmonic Power Output of a Radio Transmitter [Power delivered to Aerial measured instead of Harmonic Field Strengths at Specified Locations: Comparison Method].—P. N. Honnell and E. B. Ferrell. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 548: short summary only.)

Linear Class B Amplifiers [and Their Use as R.F. Power Amplifiers in Broadcasting Transmitters].—G. H. Miller. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 13 and 16.)

The Crystal Control of Transmitters: Telefunken High-Power Broadcasting Arrangements [with Continuously Acting Temperature Regulation].—R. Bechmann. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, pp. 249–253.)

On the Pentode Crystal Oscillator [superior to Triode in Power Output at Equal Voltages: Less Load on Crystal: recommended for Master Oscillators].—K. Hatakeyama and K. Nakanishi. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts p. 17.)

A Method of Suppressing the Carrier Wave [by applying Two Carrier Voltages, of nearly Opposite Phase, to the Two Grids of a Double-Grid Valve with One or Two Anodes].—S. Narumi. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts pp. 21–22.)

A System of Wireless Secret Telephony [Frequency Inversion System on Microphone-in-Bridge Principle: Voice Operated Relays given Necessary Time Delay by Sound Tube between Loudspeaker (fed by Voice Currents) and Microphone].—S. Chiba. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. 267–270.)

Linear Amplitude Modulation by superposing Two Waves of Equal Frequency and modulating Their Relative Phase [Cosine of Phase Angle approximately proportional to Modulation Potentials and Currents].—Siemens & Halske: Jaumann. (German Pat. 571 732, pub. 1.12.1933.)

Suppressor-Grid Modulation in the Low-Power 160-Metre Crystal-Controlled Telephone Set.—D. H. Mix. (*QST*, May, 1934, Vol. 18, No. 5, pp. 34–39 and 120.) For Lamb's papers on suppressor-grid modulation *see* June Abstracts, p. 320, l-h column, and below.

A New Pentode-Type Screen-Grid Transmitting Tube [Raytheon RK-20]: a Design for Suppressor-Grid Modulation with 50-Watt Peak Output, Small Grid/Plate Capacity and Large Power Amplification.—J. J. Lamb. (*QST*, May, 1934, Vol. 18, No. 5, pp. 71–72.)

RECEPTION

Super-Regeneration [particularly for Ultra-Short-Wave Reception, 5 to 10 Metres].—W. S. Barden. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 418–419: short summary only.)

"It was shown that the selectivity possible with this type of circuit does not permit the operation of stations separated by but small differences in frequency [*see* also Grimes and Barden, May Abstracts, p. 267]. The difficulties encountered in using a buffer stage to prevent radiation was discussed. He stated that two a.f. stages of high amplification were necessary because of the low power available from the demodulator circuit. The possibility of using super-regeneration in combination with superheterodyne circuits was regarded as valueless. As a general conclusion it was stated that super-regeneration was useful only in the very high frequency portion of the radio spectrum, and then only with wide cleared channels."

Transmission and Reception of Centimetre [Micro-] Waves.—Wolff, Linder and Braden. (*See* under "Transmission.")

Dämpfungsmessung von Entstörungs-Geräten (The Measurement of Attenuation in Receiver Devices for Eliminating Mains Noises).—O. Schütte and G. Weiss. (*Funktech. Monatshefte*, April, 1934, No. 4, pp. 133–134.)

After describing the test-room method adopted at the Heinrich-Hertz Institute for testing the merits of commercial devices of this kind, the writers give some specimen results. The best suppression effect was given by an experimental arrangement (Fig. 4) based on theoretical reasoning, in which each arm of the quadripole had two inductances in series, one large and one small. The large inductance dealt particularly with the lower frequencies, while the small inductance, which was wound to have very low self-capacity, kept back the high frequencies passing through the self-capacity of the large inductance. Careful screening of one coil from another was found advantageous.

Über eine Messmethode zur Bestimmung der Störungsgrössen beim Rundfunkempfang (A Practical Test Method of Measuring the Strength of Interference with Broadcast Reception).—F. Conrad and H. Reppisch. (*E.N.T.*, March, 1934, Vol. 11, No. 3, pp. 114–118.)

The equipment (Fig. 2) consists of a test receiver (preferably with single-knob tuning) provided with a suitable sensitivity control such as a grid-bias adjustment on the first r.f. valve. By means of this control, combined with a capacitive potential divider between the line or aerial carrying the interfering oscillations and the input terminal of the receiver, the output of a loudspeaker fed by the receiver is adjusted to a standard value (*e.g.* with the help of the Barkhausen noise meter): or the a.f. output of the receiver can be switched directly on to the acoustic meter and compared with the hummer note.

This "equal strength" procedure eliminates the complications otherwise introduced by the behaviour of a r.f. detector to noises of different wave form. But it gives the strength of the interference in terms of the sensitivity of the equipment. This quantity is quite different from the "overall amplification" used in testing receiver performances (*cf.* Troeltsch, 1931 Abstracts, p. 393) and requires a new name—the "electroacoustic overall amplification." The receiver and loudspeaker are considered as one unit, so that the volume of the loudspeaker output can be directly compared with the r.f. input—"a method which can also be used with advantage in testing the quality of receivers." Thus the unit of electroacoustic overall amplification is such that a unit of r.f. potential at the receiver input produces a unit of volume from the loudspeaker.

The equipment is calibrated with a 30% sinusoidally modulated radio-frequency voltage. This calibrating process brings up the question as to the correct level at which it should be carried out: this point is discussed in section 3. The final section gives some results of measurements on a diathermy apparatus.

The "Electroacoustic Amplification" of a Receiver: Its Definition and Measurement.—Conrad and Reppisch. (*See* above abstract.)

Radio Interference: Plan of Action of the I.E.E. Committee—Necessity for a Standard.—(*Electrician*, 27th April, 1934, Vol 112, No. 2917, p. 571.)

The Elimination of Electrical Disturbances interfering with Radio Reception: Ministerial Decrees of 30th and 31st March, 1934.—M. Adam. (*Génie Civil*, 28th April, 1934, Vol. 104, No. 17, pp. 382–383.)

Decrees of 30th and 31st March, 1934, relative to Precautions against Industrial Interference with Radio Reception.—(*Rev. Gén. de l'Élec.*, 19th May, 1934, Vol. 35, No. 20, pp. 703–704.)

High-Fidelity Receivers, Part II.—Aerial Step-Up and Thermal Noise: Cross Modulation: Image Frequency: Choice of Intermediate Frequency: Coupling of Tuned Circuits: Band Width: Selectivity.—A. G. Hanley. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 30–31 and 36.) To be continued: for Part I *see* June Abstracts, p 322, l-h column.

High Fidelity—Economics and Technique.—(*Electronics*, April, 1934, pp. 108–109.)

"The public has *not* rejected high quality receivers; it has purchased millions of units of very low tone fidelity simply because it wants music, as cheaply as possible, and has bought avidly what was offered it. The public has never heard a truly high fidelity receiver; and it is unreasonable to believe that the listener would turn his back on wide-band music in favour of a 1933 radio—under good receiving conditions." The immediate market for high-fidelity receivers will be limited to listeners living close to a transmitter. The paper goes on to discuss the lines on which such receivers should be designed: the superiority of the superheterodyne circuit is stressed, types of filter circuit are considered, and the advantage of having a band width controllable in steps is pointed out.

A Common Source of Error in Measurements of Receiver Selectivity [Increase of Thermal Agitation "First-Circuit Noise" by presence of Input Signal].—E. N. Dingley, Jr. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 546: short summary only.)

"Receiver selectivity is usually determined by measuring the amplitudes of the input signal at resonance, and at various percentages off resonance, required to maintain a constant audio output." The effect mentioned in the title is variable, according to the relation of the signal frequency to the receiver resonant frequency, so that if the total audio output is kept constant the signal component of that output is variable, and the selectivity measured may have considerable error. This may be eliminated by requiring the input signal to maintain a *constant increment of final detector d.c. plate current* rather than a constant audio output.

The Design and Testing of Multi-Range Receivers [and a Useful "Piston" Attenuator].—D. E. Harnett and N. P. Case. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 548: short summary only.)

"The attenuator comprises a pair of coplanar coils, coaxial coils, or condenser plates, one fixed and one movable axially in a moderately long cylindrical copper shield. The attenuation in db is directly proportional to the displacement of the movable element, and the calibration can be computed."

Electro-Acoustical Fidelity of Broadcast Receivers [and Its Comparison with Purely Electrical Fidelity: Test Data Curves].—I. Tanimura. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts p. 24.)

Band-Pass Filters in Receiver Design [such as the *Wireless World* "Single-Span" Receiver].—G. W. O. H.: Cauer: Glowatzki. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, pp. 231–233.) Editorial on Cauer's work and its application, particularly Glowatzki's papers (May Abstracts, pp. 266–267).

High Fidelity Receivers with Expanding Selectors [for Best Compromise between Fidelity and Selectivity for any given Conditions: Expansion controlled by moving Tuning Knob in Axial Direction: Tuning only possible when Band Width is contracted].—H. A. Wheeler and J. K. Johnson. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 554: short summary only.)

"A Theoretical and Experimental Investigation of High Selectivity Tone-Corrected Receiving Circuits" [Book Review].—F. M. Colebrook. (*L'Onde Élec.*, February, 1934, Vol. 13, No. 146, p. 12A.) Review of Radio Research Board *Special Report No.* 12: *see* also 1933 Abstracts, p. 99 (G. W. O. H.).

Positive-Grid Valve as a Detector: the "Brake-Audion" or Retarding-Field Valve as a Detector, for Broadcast and other Frequencies [and Its Use as a Detector giving Automatic Fading Compensation].—H. E. Hollmann. (*Wireless Engineer*, May and June, 1934, Vol. 11, Nos. 128 and 129, pp. 245–248 and 309–311.)

Schwundausgleich mit dem Bremsaudion (Fading Compensation with the Brake-Audion).—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, April, 1934, Vol. 43, No. 4, pp. 131–135.) Covering much the same ground as the second part of the *Wireless Engineer* paper dealt with above.

The Retarding-Field Tube as a Detector for Any Carrier Frequency.—H. E. Hollmann. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 630–656.)

Part I deals with the brake-field valve as a detector for decimetre waves, and leads up to the discussion of the "twin" receiver and push-pull brake-field receiver (March Abstracts, pp. 151–152 and back refs.). Part II deals with the brake-field valve as a detector for any carrier frequencies (such as the broadcast band) and briefly with the use of this valve for fading compensation; thus covering some of the same ground as the *Wireless Engineer* paper referred to above. "Tests with a 3-tube receiver built according to the criteria developed here have actually shown an astonishingly high overall sensitivity and fading compensation entirely sufficient for practical purposes. . . . If [by the development of special valves] the retarded characteristic can be made to approach the theoretical limits indicated by a Maxwellian velocity distribution of electrons, then we may expect an increased sensitivity of the retarding-field detector which can be approached by no other rectifier."

Graphical Solution of Automatic Volume Control [and the Action of the Variable-Mu Valve].—S. Ooka. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts p. 23.)

Übersicht über bekannte und neue Binodenschaltungen [A Survey of Well-Known and New Binode Circuits].—H. Pitsch. (*Funktech. Monatshefte*, April, 1934, No. 4, pp. 137–140.)

In a previous paper (March Abstracts, p. 152) the writer dealt with the use of retroaction with a binode, and in the present paper two other articles, on the two fundamental methods of connecting the binode (" parallel " and " series " connections) and on retroaction, are referred to. The present paper deals with modifications of these circuits, and shows that it is impossible to say that one or other mode of connection is the best : each has its own advantages for particular requirements. Thus if for reasons of economy choke-coupling is not wanted, and other considerations rule out an inductive coupling, the " parallel " connection must be used, particularly the circuit of Fig. 3 (where the inductance is connected to the anode supply and the condenser rotor to earth) ; if for any reason retroaction coupling is inadmissible, the best circuit for high selectivity is that of Fig. 5 (" parallel," with r.f. choke to prevent damping effect of leak resistance *W*, and volume control). If, however, the anode current is to be carried through a choke or a coupling coil, the circuits of Figs. 10 and 11 (" series," oscillatory circuit to cathode, and " series," with grid bias taken from a resistance traversed by the anode current of the binode only) are advantageous when a retroactive coupling is to be used. Both " series " and " parallel " connections require at least one choke, except where " series " connection is used with inductive coupling.

Fig. 13 gives a " series " circuit with r.f. amplification ; Fig. 14 is a modification of Fig. 11 with the addition of volume control ; Figs. 15 and 16 are retroaction circuits, the former using only a portion, and the latter the whole, of the r.f. potentials.

DER WACHSENDE HEXODEN-SUPERHET (The " Expanding " Hexode Superheterodyne Receiver).—Th. Sturm. (*Funktech. Monatshefte*, April, 1934, No. 4, pp. 151–159 : to be continued.) For " expanding " receivers *see* January Abstracts, p. 37, l-h column.

KURZWELLENEMPFANG MIT RUNDFUNKEMPFÄNGERN (Short-Wave Reception with Broadcast Receivers).—E. Schwandt. (*Funktech. Monatshefte*, April, 1934, No. 4, pp. 141–149.)

THE PEOPLE'S RECEIVER [Volksempfänger] VE301. —P. Gehne. (*E.T.Z.*, 15th Feb., 1934, Vol. 55, No. 7, pp. 157–158.)

THE REGENERATIVE SINGLE-SIGNAL RECEIVER BROUGHT UP-TO-DATE : A SIX-TUBE VERSION INCORPORATING PRE-SELECTION.— R. W. Woodward. (*QST*, May, 1934, Vol. 18, No. 5, pp. 64–68 and 100, 102, 104.)

REGENERATION IN THE TUNED R.F. STAGE : A SIMPLE METHOD OF INCREASING THE SELECTIVITY AND THE SENSITIVITY OF THE TUNED R.F. RECEIVER.—W. Sullivan and F. Kienle. (*QST*, May, 1934, Vol. 18, No. 5, pp. 53–55 and 118.)

COILS AND CIRCUITS [R.F. and I.F. : especially for Dual-Wave and All-Wave Receivers : Overload Prevention System for Receivers without AVC : etc.].—H. J. Benner. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 24–26.)

DER " ANODENSTROMSPARER," EINE WICHTIGE NEUERUNG FÜR JEDEN BATTERIEEMPFANGER (The " Anode Current Economiser," an Important Innovation for All Battery-Driven Receivers [Quiescent Output Valve using Its Own A.F. Voltages, rectified by Dry-Plate Rectifier, to provide Automatic Bias Regulation : used in the " Volks " —People's—Receiver]).—Nestel : Telefunken. (*Die Sendung*, 18th May, 1934, Vol. 11, No. 21, p. 410.)

THE " SIRUTOR " CARTRIDGE-TYPE DRY-PLATE RECTIFIER.—Siemens Company. (Used in the arrangement referred to above.)

A DE LUXE CRYSTAL TYPE SINGLE-SIGNAL RECEIVER WITH BUILT-IN MONITOR.—L. Moffett, Jr. (*QST*, May, 1934, Vol. 18, No. 5, pp. 40–45 and 114, 116, 118.)

THE RECEPTION OF WIRELESS SIGNALS IN NAVAL SHIPS.—W. F. Rawlinson. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, pp. 255–258.) Summary of an I.E.E. paper and subsequent discussion.

NEW AIRPORT RECEIVERS [Types 11A and 11B].— H. B. Fischer. (*Bell Lab. Record*, May, 1934, Vol. 12, No. 9, pp 258–263.)

A HIGHLY SELECTIVE WEATHER AND BEACON RADIO RECEIVER FOR AIRPLANE USE.— W. E. Reichle. (*Bell Lab. Record*, May, 1934, Vol. 12, No. 9, pp. 264–267.)

REMOTE TUNING CONTROLS FOR AIRCRAFT RADIO RECEIVERS.—B. O. Browne. (*Ibid.*, pp. 268–272.)

A SHARPLY TUNED RADIO RECEIVER WITHOUT ANY INDUCTANCE COILS.—van der Mark and van der Pol. (*See* abstract under " Properties of Circuits.")

WHAT IS DEMODULATION ?—A. W. Ladner : G.W.O.H. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, pp. 253–254.) *See* June Abstracts, p. 323, r-h column.

AERIALS AND AERIAL SYSTEMS

A NEW TYPE OF HARMONIC ANTENNA [Electric Field Distribution of $3\lambda/2$ Horizontal Aerial altered to give Two Large Sharp Loops in Forward and Backward Directions : Latter reflected by $\lambda/2$ Reflector, giving Sharp Forward Loop : Successful in Narrow Zone of S. Manchurian Railway].—H. Kikuchi, Y. Aoi, and S. Yamaguchi. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, pp. 214–216 : English summary pp. 24–25.)

CONTROL OF RADIATING PROPERTIES OF ANTENNAS [through Very Wide Range, by varying Current Distribution by Concentrated Capacity at Top : Many Advantages, especially for Waves between 600 and 1 Metre].—C. A. Nickle, R. B. Dome, and W. W. Brown. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 551–552 : short summary only.)

Aerial Resistance and Aerial Termination. Part I [Discussion of the Term " Radiation Resistance " : Its Lack of Specific Meaning for Modern Aerials : Effect of Earth's Proximity : the Advantages of High Vertical Aerials : the Marconi " Uniform " Vertical Aerial and the Marconi-Franklin Series-Phase Aerial].—N. Wells. (*Marconi Review*, March/April, 1934, No. 47, pp. 13–20.)

Antenna Measuring Set [for Measuring Resistive and Reactive Components of Antenna and Transmission Line Impedance, and the Terminating Impedance at Antenna-End of Transmission Line].—W. B. Lodge. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 14–16.)

Surge Impedance of Antenna Element.—G. Hara. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts pp. 18–19.)

On the Electric Field near the Antenna [Approximate Theory].—K. Hashida. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, pp. 194–200 : English summary pp. 20–21.)

[Ultra-]High-Frequency Models in Antenna Investigations [on the Effect of Separation of Resonant and Non-Resonant Towers on the Field Patterns of Broadcasting Transmitters].—G. H. Brown and R. King. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 457–480.)

Theories of Receiving Antennas [Variation of Received Current and Power due to Change in Impedance of Load : Effect of Free Aerial in front of and behind Receiving Aerial : Application to Beam Arrays : Properties identical whether Transmitting or Receiving : etc.].—T. Mizuhashi and I. Taki. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts pp. 19–20.)

Electric Wave Gratings of First and Second Kinds [Part IV (contd.) of " Multi-Hertzian Oscillators "].—H. Kikuchi. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, pp. 185–189 : English summary pp. 19–20.)

Continuation of the work referred to in June Abstracts, p. 324, l-h col. " The grating of the first kind is made up of a certain number of conducting cylinders of the same length, arranged at the same interval. In this example 9, 5, 3 or 2 cylinders are placed with the same interval within a distance of 600 cm. and the wavelength of the incoming waves is 300 cm." The second kind of grating is composed of conducting cylinders of *different* length arranged in the form known as the " harp-shaped grating." The tests showed that the "first kind " grating has multi-reflection and multi-refraction angles which are functions of the incident angle (phase angle of re-radiation) and the spacing of grating, while that of the " second kind " has " simple and smoothing " reflection and refraction angles.

Propagation of High-Frequency Currents in Ground Return Circuits [Calculation of Electric Field without assuming Frequency so low that Polarisation Currents in Ground may be Neglected].—W. H. Wise. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 522–527.)

" It is found that the polarisation currents may be included by replacing the r in Carson's well-known formulas by $r\sqrt{1 + i(\epsilon - 1)/2c\lambda\sigma}$." For corrections see *ibid.*, May, p. 563.

A Method of Damping the Vibrations of Overhead Lines [Hollow Conductor with Internal Wire stretched to give a Different Period].—M. Preiswerk. (*Bull. Assoc. suisse des Élec.*, No. 10, Vol. 25, 1934, pp. 252–253.) Based on the fact that two loosely coupled parallel wires with different periods come to rest at once after a shock.

The Removal of Ice and Snow from Power Lines [a New " Ice-Knife " sliding on Line and pulled along from below].—O. Strand. (*E.T.Z.*, 17th May, 1934, Vol. 55, No. 20, pp. 491–492.)

VALVES AND THERMIONICS

A Suitable Triode for Generating Electron Oscillations [Micro-Waves, by Brake-Field Method].—K. Kamio. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. 229–249.)

The Barkhausen-Kurz equation indicates that the wavelength may be decreased either by reducing the electrode dimensions or by increasing the positive potential of the grid. The author has used the second alternative, constructing a triode " SN–603 " in which special radiators are mounted on both sides of the grid spiral so as to increase the maximum permissible grid dissipation. With an anode of the rather large diameter of 1.8 cm, it was possible to use grid potentials up to 1 200 volts, " which seems to be the highest voltage so far applied," giving a wavelength of 52 cm. Several pitches of grid spiral were tested : the best value found was 1.15 mm, and the best thickness of wire 0.2 mm.

It was ascertained that the most suitable value for the ratio of plate diameter to grid diameter was about 2 : 1 ; the three electrodes must be exactly concentric. The shorter the wavelength the larger must be the filament emission. Straight, pure tungsten wire makes the best filament. The higher the evacuation the better, but a large bulb is desirable in order to avoid sputtering. Three methods of measuring the wavelength were tried, using plate-current change as indication : all the results were in close agreement. Both BK and GM oscillations were found to be present simultaneously.

On Tubes for producing Decimetre-Wave [Micro-Wave] Oscillation.—S. Ohtaka and M. Ogawa. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, p. 236 : in Japanese, with diagrams.)

An Electronic [Micro-Wave] Oscillator with Plane Electrodes [and a Fourth Element called a "Backing Plate": Non-Critical Filament Voltage and only One Mode of Oscillation: Wavelengths less than 10 cm with Positive Grid Voltage of 250 Volts].—B. J. Thompson and P. D. Zottu. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 553–554: short summary only.)

Short-Wave Oscillators [Ultra-Short-Wave Valves: Summary of Paper and Discussion].—E. C. S. Megaw. (*Journ. Television Soc.*, December, 1933, Series 2, Vol. 1, Part 9, pp. 288–290.)

Linear Class B Amplifiers [and Their Use as R.F. Power Amplifiers in Broadcasting Transmitters].—G. H. Miller. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 13 and 16.)

A New Pentode-Type Screen-Grid Transmitting Tube [Raytheon RK–20]: a Design for Suppressor-Grid Modulation with 50-Watt Peak Output, Small Grid/Plate Capacity and Large Power Amplification.—J. J. Lamb. (*QST*, May, 1934, Vol. 18, No. 5, pp. 71–72.)

Resistenze negative di Tubi elettronici e loro Misura (The Negative Resistances of Electronic Tubes, and Their Measurement [including a New Method giving Direct Reading on Ordinary Decade Resistance Box: Low Negative Resistances obtained with Pentodes]).—A. Pinciroli. (*Alta Frequenza*, February, 1934, Vol. 3, No. 1, pp. 5–19.)

Aspects of Modern Technique in the Manufacture of Receiving Valves [including the Trend towards Larger Outputs in Smaller Bulbs, and the Consequent Troubles and Their Cure: Grid Emission reduced by Carbon Coating, etc.].—E. Jervis. (*Alta Frequenza*, February, 1934, Vol. 3, No. 1, pp. 33–45.)

Space-Charge-Grid Tube with Variable-Mu Grid.—W. Dehlinger. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 563: abstract only.)

This theoretical investigation gives solutions of the generalised equations of the variable-mu triode, using Gamma functions. Graphical methods enable the distribution of grid pitches to be determined from the solutions.

A Survey of Well-Known and New Binode Circuits.—Pitsch. (*See* under "Reception.")

Die Hexode als Mischrohr im Schwebungssummer [The Hexode as the Mixing Valve in a Heterodyne Note Generator].—U. Bab and Th. Schultes. (*E.N.T.*, March, 1934, Vol. 11, No. 3, pp. 110–114.)

Authors' summary:—"The suitability of the hexode as the mixing valve in a heterodyne note generator is examined. For this purpose the hexode can be used for the simultaneous generation of one r.f. potential, but a greater output with approximately the same factor of non-linear distortion can be obtained by generating the two r.f. potentials in two separate valves and using the hexode simply as a mixing valve. The simultaneous generation of the *two* r.f. potentials in the hexode itself is found to be unsatisfactory." Fig. 2 shows the first arrangement mentioned, where a triode generating one radio frequency is combined with the hexode. For a frequency of 2×10^5 c/s this circuit gave such a constancy of frequency that the note produced varied less than 1 cycle in an hour. The increased efficiency, however, obtained with the second arrangement, using a second triode to generate the second radio frequency, justifies the additional valve by reducing the number of a.f. stages required, the a.f. voltage obtainable being about 100 times that from the first circuit (Fig. 2). The third arrangement, dismissed as unsatisfactory, is complicated and unstable: over a large part of the a.f. range the production of the note frequency is hindered by "ziehen" and "mitnahme" effects.

Der wachsende Hexode-Superhet [The "Expanding" Hexode Superheterodyne Receiver].—Sturm. (*See* under "Reception.")

The Positive-Grid Valve as a Detector: the "Brake-Audion."—Hollmann. (*See* under "Reception.")

Vacuum Tubes for measuring Very Small Currents and Potentials [Special Electrometer Space-Charge Tetrode with Input Resistance Control-Grid/Filament as high as 10^{16} Ohms: Mazda UX-54].—S. Hamada. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. 209–216.)

A Low Grid Current Vacuum Tube and Its Use [for Accurate Measurement of Currents around 10^{-15} Ampere].—S. Hamada. (*Jap. Journ. of Phys.*, 28th Feb. 1934, Vol. 9, No. 1, Abstracts p. 29.)

Wire in Tubes [Special Composite Wires for Grid and Lead-In Purposes: Copper-Alloy Core bonded to Nickel Sleeve: "Kulgrid C" Stranded Wire: Microphotographs of Tungsten-Rod/Stranded-Wire Welds: etc.].—C. A. Laise and J. Kurtz. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 29 and 36.)

Raw Materials in Vacuum Tube Manufacture [and Their Misuse].—E. R. Wagner. (*Electronics*, April, 1934, pp. 104–106.)

"Tradition still plays a large part in vacuum tube manufacture. Materials are used and treated by rule-of-thumb methods often carried over from lamp practice. Secret formulas still control the coating of filaments and cathodes, and methods of cleaning one metal are often applied to metals new to the tube art, with the result, frequently, that the new metal is condemned."

An Apparatus for the Optical Projection of Thermionic Valve Characteristics.—F. C. Connelly. (*Proc. Phys. Soc.*, 1st May, 1934, Vol. 46, Part 3, No. 254, pp. 384–390.) For Hollmann's "comparator," using cathode-ray oscillograph, *see* June Abstracts, p. 325, l-h column.

Anomalous Changes in Temperature due to Thermionic Emission in the Filaments of Valves [Effect of Radiation from the Anode].—A. M. Ferasah. (*Proc. Phys. Soc.*, 1st May, 1934, Vol. 46, Part 3, No. 254, pp. 338–343.)

On the Thermionic Emission from Oxide Cathodes [Maxwellian Velocities below 1 200° K, Much Higher above: Explained by Local Counter-Field due to Positive Ion Layers around Cathode].—S. Hamada. (*Jap. Journ. of Phys.*, 28th Feb. 1934, Vol. 9, No. 1, Abstracts pp. 28–29.)

A New Method of Investigating Thermionic Cathodes.—C. G. Found. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, pp. 519–526.)

Author's summary:—Under certain conditions, the electron current from a thermionic cathode is determined by the positive ion current reaching it. Two methods of using this relation to measure the thermionic emission of a cathode in a gaseous discharge are described. The constants [in Richardson's equation] $b_0 = 30\,000$, $A = 10$ for a thoriated tungsten filament, and $b_0 = 22\,700$, $A = 88$ for an oxide-coated cathode, were obtained by use of these methods. The zero-field emission of an oxide-coated cathode was found to be only about 10% of the current at which the cathode was normally operated in practical discharge tubes. The increased current is due to the influence at the cathode of an external field which is established by an increase in the rate of generation of positive ions. The emission increases linearly with field up to fields of 150 volts/cm. Use is made of an auxiliary discharge to determine the relative ionising power of electrons of different velocities. With cumulative ionisation predominating, the total ionising power increases linearly with the accelerating potential of the electron for voltages above the resonance potential and up to about two or three times this value.

X-Ray Determination of the Chemical Composition of Oxide-Coated Cathodes.—W. P. Jesse. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 563: abstract only.)

Fluctuations of Resistance in a Metallic Conductor of Small Volume [Thermal Agitation Phenomena in a Very Thin Metallic Film increased by Passage of Direct Current: Conclusions regarding Number of Free Electrons: etc.].—J. Bernamont. (*Comptes Rendus*, 14th May, 1934, Vol. 198, No. 20, pp. 1755–1758.)

"Replacing the telephones by a thermoelectric couple connected to a galvanometer, I find that for a given deposit the deflection is proportional to the square of the current circulating in the deposit. I consider that this phenomena may be attributed to fluctuations of resistance of electronic origin." Investigations with amplifiers of different frequency characteristics are discussed: thus a relation resembling that obtained by Schottky for "flicker effect" is obtained. Finally, "the observed fluctuations of resistance can only be explained, if in fact they are due to the granular structure of electricity, by the theory of free electrons," and experiments on these lines provide means for measuring the number of free electrons per cm^3.

"Physics of Electron Tubes" [Book Review].—L. R. Koller. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, p. 258.)

DIRECTIONAL WIRELESS

On Directional Observation of Long-Distance Short-Wave Stations and the Relation between Directional Deviation and Scattering in the Ionosphere.—T. Nakai. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. 251–258.)

Author's summary:—"This paper describes the results of directional observations carried out with long-distance short-wave stations [Melbourne, New York, Buenos Aires, Rio de Janeiro] outside the skip distance, at the Hiraiso Branch of the Tokyo Electrotechnical Laboratory, since the autumn of 1932. These results show that waves may arrive from directions deviating by more than ten degrees, or even several decades of degrees, from the true direction at almost regular times of the day. These deviations appear to be due to scattered waves from the ionised medium about the transmitting station. These results also show that the ionosphere is made up of ionic clouds of a very complicated nature, in which scattering plays an important rôle in the propagation of short waves." It is suggested that for communication with Rio and Buenos Aires the Japanese transmitting aerials would give better results if set at angles other than those of the true bearings.

On the Transmission of Short Waves through the North-Polar Night Zone [and the Arrival in Japan of Waves from New York and Rio de Janeiro "from Unexpected Directions"].—T. Nakai and M. Nakagami. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. 259–266.)

Between December, 1932, and February, 1933. These waves would be expected to pass through the polar night zone at the North pole, but were found to come scarcely ever from the expected direction, arriving from quite unexpected quarters (*e.g.* + 70°, − 20°, or "no bearing"). "It appears that short waves are very difficult to propagate through the north polar night zone, though details in regard to the ionisation in this zone are still unknown."

Elimination of Phase Shifts between the Currents in Two Antennas [due to Capacity or Resistance Variations: application to Adcock Aerials].—Roder. (*See* June Abstracts, p. 324.)

Screen [responding to Horizontal Component] of Horizontal Receiver-Lead symmetrically Coupled to the Two Vertical Aerials, to avoid Errors in Adcock-Type Systems.—Telefunken: Gothe. (German Pat. 589 831, pub. 15.12.1933: *Hochf:tech. u. Elek:akus.*, April, 1934, Vol. 43, No. 4, p. 143.)

Field Strength Measurements and Directional Observations of High-Frequency [Short] Radio Waves at the Electrotechnical Laboratory, Ministry of Communications—III.—T. Nakai. (*Rep. of Rad. Res. in Japan,* December, 1933, Vol. 3, No. 3, pp. F-53–F-91.) For previous parts *see* January Abstracts, p. 41.

Aircraft or Ship Beacon with Several Beams each with Its Identifying Signal: Borders of Route indicated by Overlapping Zones giving Double Signals.—Telefunken: Leib and Scharlau. (German Pat. 588 867, pub. 30.11.1933.)

Patents on Ultra-Short-Wave Beacons and Landing Beams.—C. Lorenz Company. (German Pats. 589 149 and 589 150, pub. 4 and 5.12.1933: *Hochf:tech. u. Elek:akus.,* April, 1934, Vol. 43, No. 4, p. 143.) *See* Kramar, Abstracts, February, pp. 95–96 and 96: *also* January, p. 42, l-h column.

The Automatic Radio Beacon Station in Korea, Japan.—K. Umeda and J. Yoshimura. (*Rep. of Rad. Res. in Japan,* December, 1933, Vol. 3, No. 3, Abstracts p. 25.)

A Highly Selective Weather and Beacon Radio Receiver for Airplane Use.—Reichle. (*See* under " Reception.")

Regional Conferences on the Organisation of the Maritime Radio Beacon Services.—(*Rev. Gén. de l'Élec.,* 21st April, 1934, Vol. 35, No. 16, p. 126 D: summary of *Journa télégraphique* article.)

ACOUSTICS AND AUDIO-FREQUENCIES

The Public Address Equipment on the Tempelhofer Field for the 1st May Celebrations: Telefunken " Mushroom " Loudspeakers.—G. Büscher. (*Die Sendung,* 4th May, 1934, Vol. 11, No. 19, p. 366.)

The " mushroom " loudspeaker directs the sound vertically upwards, but a reflector (1.1 m diameter) mounted just above the basin-shaped horn reflects it side-ways all round towards the ground. Each loudspeaker is mounted on a 3.5 m mast. The ground to be covered was over half a million square metres, and an audience of about 2 millions had to be provided for: 122 of the " mushrooms " were used.

The Problem of Class B Amplification [and a Telefunken High-Quality Amplifier for Gramophone and Microphone, with 20 Watts Output].—P. Hatschek. (*Radio, B., F. für Alle,* March, 1934, No. 3, pp. 39–42.)

Strength of Loudspeaker Moving Coil increased by using Wire of Trapezoidal Section.—Telefunken. (German Pat. 554 795, pub. 20.12.1933: *Hochf:tech. u. Elek:akus.,* April, 1934, Vol. 43, No. 4, p. 143.)

Efficiency of Cone Type Moving-Coil Loudspeaker [and the Comparison between Electro-Mechanical and Electro-Acoustical Efficiencies].—H. Wada. (*Journ. I.E.E. Japan,* March, 1934, Vol. 54 [No. 3], No. 548, pp. 190–194: English summary p. 20.)

The Detection and Measurement of the Longitudinal Curvature of Small Surfaces of Any Cross-Section [Application to Examination of Fine Wires, Curvature of Small Coils, etc., of Method developed for Gramophone-Record Sound Tracks].—H. E. Gauss. (*Journ. Scient. Instr.,* May, 1934, Vol. 11, No. 5, pp. 157–162.)

On the Sound Emission by a Vibrating Membrane [Experimental Work in a Fluid: Formulæ calculated with help of Spherical Model: Comparison with Directive Properties of a Cone Loudspeaker].—M. Sasao. (*Jap. Journ. of Phys.,* 28th Feb. 1934, Vol. 9, No. 1, Abstracts p. 8.)

A Stiffness Meter for Loudspeaker Cones.—D. A. Oliver. (*G.E.C. Journal,* May, 1934, Vol. 5, No. 2, pp. 73–78.)

Deflections are observed directly, on a precision dial indicator, for known forces produced by dead weight loading. The range is about 0.1 to over 10 megadynes/cm, with an accuracy within 2%. Typical results are given on cones and centring devices for m.c. loudspeakers. A mechanical hysteresis loop for a moulded paper cone is shown, and a curve depicting the variation in stiffness with clamping radius. The force/deflection curves and harmonic production for two different types of centring spiders are compared.

Radio [with Gramophone and Public Address] in Hospitals.—H. W. Schuler. (*Bull. Assoc. suisse des Élec.,* No. 10, Vol. 25, 1934, pp. 261–262.)

A Lapel Microphone of the Velocity Type [Flat Characteristic from 80–7 000 c/s: Compensated for Diffraction around Head: Output constant when Head is turned: Satisfactory Sensitivity with Weight only 3 oz].—H. F. Olson and R. W. Carlisle. (*Proc. Inst. Rad. Eng.,* May, 1934, Vol. 22, No. 5, p. 552: short summary only.)

The Carbon Microphone: an Account of Some Researches bearing on Its Action.—F. S. Goucher. (*Bell S. Tech. Journ.,* April, 1924, Vol. 13, No. 2, pp. 163–194.) *See* June Abstracts, p. 327, r-h column.

The Use of the Water-Jet Microphone for Observing and Recording Noises, Vibrations, Geiger Counter Impulses, etc.—Greinacher. (*See* under " Subsidiary Apparatus and Materials.")

The Application of Photoelectric Cells to the Synthesis of Sounds in Musical Instruments [Photoelectric Organ or " Cellulophone "].—P. Toulon. (*Rev. Gén. de l'Élec.,* 10th March, 1934, Vol. 35, No. 10, pp. 297–298.)

THE USE OF THE QUANTITY "ELECTROACOUSTIC OVERALL AMPLIFICATION." — Conrad and Reppisch. (*See* abstract under "Reception.")

AN ACOUSTICAL PROBLEM RELATING TO THE THEORY OF THE RAYLEIGH DISC [lying Obliquely in the Field of Infinite Plane Sound Waves].—M. Kotani. (*Jap. Journ. of Phys.*, 28th Feb. 1934, Vol. 9, No. 1, Abstracts p. 8.)

A MODULATION MEASURING APPARATUS (Impulse Meter): ITS CONSTRUCTION AND APPLICATION IN THE HOME-RECORDING OF GRAMOPHONE RECORDS.—J. Kessler. (*Funktech. Monatshefte*, April, 1934, No. 4, pp. 159–164.)

ÜBER DIE BRAUCHBARKEIT ELEKTRODYNAMISCHER STROMMESSER IM TONFREQUENZGEBIET (The Suitability of Electrodynamic Current Meters for Use in Audio-Frequency Measurements [and the Employment of Correcting Circuits]).—E. Hölzler. (*E.N.T.*, April, 1934, Vol. 11, No. 4, pp. 154–155.)

Up to the present such meters have been used hardly at all for audio-frequencies, since their sensitivity was too small for the low powers hitherto involved; the increased powers in use to-day, however, raise the question of the accuracy of such instruments for audio-frequencies. Previous writers have dealt only qualitatively with this point.

"If the coils of an electrodynamic meter are connected in series, the error occurring as the frequency is increased depends only on the displacement currents and the eddy currents. The former pass chiefly through the winding- and layer-capacities of the individual coils. This effect can be demonstrated by connecting a condenser across the coil: the branch current flowing through the coil is greater than the total current brought to the parallel combination, and the instrument reads high. With ordinary designs this effect begins to show itself above about 5 000 c/s. Eddy currents in metal parts show themselves by a decrease of the mutual inductance between the coils," and thus make the meter read low. By representing the formation of eddy currents by a third circuit coupled to both coils, it is found that the error increases almost quadratically with the frequency and then approaches a constant value. The amount of the error depends very much on the design of the instrument.

The writer compares the results with two iron-free meters, one ("A") of Bruger's special design, with flat coils, as few metallic parts as possible, and fibre suspension, and the other ("B") of ordinary design. Meter "A" *showed no variation of reading with frequency*: the errors of meter "B" are shown in Fig. 1a for three different deflections at various frequencies. Up to about 5 000 c/s they agree with those calculated from the measurement of mutual inductance, and are thus due to eddy currents: above this frequency they become smaller, owing to the influence of the displacement currents.

It is seen, therefore, that a suitably designed meter can be used straight away in the audio-frequency range. The most important point is the greatest possible elimination of metallic parts (formers, damping cages, etc.) near the coils. On the other hand, the behaviour of an ordinary meter can be corrected in various ways. The common method of a parallel-connected choke only equalises the errors correctly if the time constant of the meter is considerably reduced by the addition of resistances: this would greatly increase the energy requirements. Fig. 2 shows a connection, using a transformer, which is free from this objection: the decrease of time constant is obtained by the inductive application, to the instrument circuit, of an auxiliary voltage of opposed phase. Fig. 1b shows that such an arrangement keeps the error of meter "B," which previously rose to about 2.5%, down to 0.5%, provided the upper frequency limit is taken as 5 500 c/s. The weight of the correcting circuit is 225 gm. The resulting increased energy requirement is shown in Fig. 3a. "Since for error-elimination the current in the instrument itself must be rather greater than that led to the whole arrangement, a completely loss-free equalising device gives an energy-requirement increase representing the limiting value obtainable under the best conditions (Fig. 3b). The inclusion of such an arrangement would be particularly useful in iron-cored instruments."

PRECISION HETERODYNE OSCILLATORS [and the Design Features affecting Calibration Permanence and Frequency Drift: Special Logarithmic Variable Condenser avoiding Exaggerated Plate Shapes by varying Number of Plates engaged: the Ryall-Sullivan Oscillator].—W. H. F. Griffiths. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, pp. 234–244.)

THE HEXODE AS THE MIXING VALVE IN A HETERODYNE NOTE GENERATOR.—Bab and Schultes. (*See* under "Valves and Thermionics.")

"B" BATTERYLESS TRIODE OSCILLATOR WITH AUDIO-TRANSFORMER.—R. Usui. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, p. 234: in Japanese, with diagrams.)

A SIMPLE NOTE GENERATOR [Frequency continuously variable over Short Range, *e.g.*, 1 300—2 000 c/s: Microphone and Telephone in Insulating Tube, with Adjustable Distance].—F. W. Gundlach. (*Funktech. Monatshefte*, April, 1934, No. 4, pp. 149–150.)

SUR UN MONTAGE SIMPLIFIÉ À RÉACTION SENSIBLEMENT INDÉPENDANTE DE LA FRÉQUENCE DE SÉLECTION (A Simplified Retroaction Circuit practically Independent of the Selection Frequency [suitable for Audio-Frequency Oscillator or Selective Amplifier: Simpler and More Sensitive than Bridge Connection, but Less Stable and More Liable to introduce Non-Linear Distortion]).—M. Lévy. (*Revue d'Acoustique*, November, 1933, pp. 471–483.) *See* also 1932 Abstracts, p. 338.

NEW METHOD OF AMPLIFYING AND PRODUCING OSCILLATIONS OF LOW FREQUENCY [2—15 000 c/s].—Jonescu and Cerkez. (*See* under "Transmission.")

Design of Wide-Range Audio Transformers [30—15 000 c/s].—I. A. Mitchell. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 22–23 and 34.)

Sur les Proprietés des Montages à Contre-Réaction (The Properties of Counter-Retroaction Circuits [Stabilised Feed-Back Amplifier Circuits]).—J. Bernamont and M. Lévy: Black. (*Comptes Rendus*, 7th May, 1934, Vol. 198, No. 19, pp. 1674–1676.)

"In the course of researches on retroaction we have shown, in particular, that counter-retroaction applied to an amplifier circuit allows its action to be stabilised and the distortions due to the curvature of the characteristics to be eliminated [various patents and papers are referred to: *see*, for example, 1932 Abstracts, p. 338, Brillouin and Lévy]. We propose in this Note in the first place to give briefly the theory of counter-retroaction applied to non-selective amplifiers, and in the second place to describe a particularly simple arrangement. Since, however, our calculations resemble those of Mr. Black in a publication (May Abstracts, p. 272, l-h col.) of which we have only just become aware, we shall only dwell on those points where the differences are important."

Dealing with an amplifier of amplification coefficient K with input and output linked by a coupling element of amplification coefficient K', and assuming negligible distortion, the writers first show that for equal output voltage the working characteristic of each valve is the same whether there is retroaction or not. If $|1 - KK'| < 1$, the sensitivity of the amplifier is increased: the retroaction is positive. If $|1 - KK'| > 1$, the sensitivity is decreased: the retroaction is negative—there is counter-retroaction. This may attain very large values: in actual practice it is of the order of 200 to 1 000.

Dealing then with stability, the analysis shows that circuits with retroaction behave as if the stability varied inversely with the sensitivity. With circuits without retroaction, on the other hand, the behaviour depends on the way in which the sensitivity is decreased. Thus if, for example, the number of stages is reduced, the sensitivity alters in geometrical progression and the stability in arithmetical progression. If, on the other hand, the sensitivity is decreased by adjusting a potentiometer somewhere in the circuit, the stability is not changed. If, finally, the sensitivity is altered by bias adjustment, it is very probable that the stability will vary little, owing to the multiple causes intervening to produce instability. It appears, therefore, that in all three cases the stability decreases less quickly than the sensitivity.

It is deduced from the above that *it is always advantageous to employ counter-reaction in order to vary the sensitivity or to increase the working stability.*

If distortions occur, the equations previously arrived at can still be applied provided each amplification coefficient is considered as applying to the fundamental. If the proportion of harmonics is small, the equations show that the working characteristics are still the same with or without retroaction. At a first approximation it may be taken that each valve produces the same proportion of harmonics in the two cases. But with retroaction the *amplification* of each harmonic is $(1 - KK')$ times smaller, K and K' corresponding to the frequency of the harmonic in question. *The reduction of the amplitude of each harmonic is therefore practically proportional to the diminution of sensitivity for the corresponding frequency, due to the retroaction.*

A very simple example of a counter-retroaction amplifier is provided by a single valve with a non-shunted resistance, r, between cathode and earth. The circuit then behaves as if the valve had an apparent resistance $\rho_a = \rho + (K + 1)r$; if, for example, the slope is 2 mA/v and $r = 50\ 000$ ohms, ρ_a is approximately equal to $100\ \rho$. This circuit may with advantage be used to replace the regulation of sensitivity by bias adjustment, simultaneously improving the characteristics of the valve.

Open-Wire Crosstalk [in Telephone Lines].—A. G. Chapman. (*Bell S. Tech. Journ.*, April, 1934, Vol. 13, No. 2, pp. 195–238.) Continuation of paper dealt with in May Abstracts, p. 272, r-h col. This part deals with the effect of constructional irregularities and with wire configurations. The appendix deals with the calculation of crosstalk coefficients.

Telephony by Pulsating Currents.—M. Marro. (*Ann. des P.T.T.*, April, 1934, Vol. 23, No. 4, p. 404.)

"A telephonic circuit with loaded cable transmits a sinusoidal alternating current with an attenuation which, in the 200–1 200 c/s band, varies considerably with the frequency. By placing a rectifier at the start of the circuit in such a way as to suppress every other alternation, the sinusoidal current is transformed into a pulsating current: experiment has shown that the attenuation undergone by this pulsating current in a loaded cable . . . is almost independent of the frequency; in practice, the circuit ends in a transformer so that at the receiving end an alternating, not a pulsating, current is obtained. In the writer's tests, over a cable section of 80 km loaded with 177 mH coils at intervals of 1.8 km, the current observed at the receiving end is practically sinusoidal." Oscillograms show that the process does not appreciably alter the form of the currents, so that it should be valuable in combating distortion due to attenuation in long-distance telephony; it may also be applied to high-frequency carrier-current telephony.

The Cathode-Ray Oscillograph in Speech Recording and Analysis [Continuous-Film Records at Speeds of 6ft/sec. using Deep-Blue-Response Screen and Moving-Film or Drum Camera].—R. Curry. (*Journ. Scient. Instr.*, May, 1934, Vol. 11, No. 5, pp. 162–164.)

The "Sound Prism" [for Rapid Sound Analysis: Heterodyne Wave Analyser: Frequency Spectrum repeatedly traced on Translucent Screen so that Eye sees it as Steady Line or Group of Lines: Changes in Spectrum continuously followed by Eye as Composition of Sound changes].—K. McIlwain and O. H. Schuck. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 551: short summary only.)

ARTICULATION TESTING, *and* AUTOMATIC ARTICULATION TESTING APPARATUS.—W. A. Munson: L. Y. Lacy.—(*Bell Lab. Record*, May, 1934, Vol. 12, No. 9, pp. 273–275: 276–280.)

ELECTRO-ACOUSTICAL RESEARCHES ON THE "TIMBRE" OF THE HUMAN VOICE.—A. Gemelli and G. Pastori. (*La Ricerca Scient.*, 31st March, 1934, 5th Year, Vol. 1, No. 6, p. 339: summary only.)

TONE QUALITY [Two Components, Timbre and Sonance (depending on Change in Timbre in a Sequence of Waves)].—C. E. Seashore. (*Science*, 11th May, 1934, Vol. 79, No. 2054, p. 437: summary only.)

ACOUSTIC VOCABULARY.—C.C.I.F. Committee. (*Ann. des P.T.T.*, April, 1934, Vol. 23, No. 4, pp. 380–398.)

SUPERSONIC WAVES [Survey with 98 Literature References, including Work on Measuring Methods, Chemical and Biological Action, and Optical Effects].—W. Rodewald. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 15, 1934, pp. 192–200.)

THE VIRUCIDAL ACTION OF HIGH FREQUENCY [Supersonic] SOUND RADIATION [Experiments on Tobacco Leaf Virus].—W. N. Takahashi and R. J. Christensen. (*Science*, 4th May, 1934, Vol. 79, No. 2053, pp. 415–416.)

PHOTOTELEGRAPHY AND TELEVISION

ON THE THEORY OF THE GAS-FOCUSED CATHODE-RAY BEAMS.—J. Frenkel and S. Bobkovsky. (*Physik. Zeitschr. der Sowietunion*, No. 3, Vol. 5, 1934, pp. 464–502: in English.)

The parallel work of Scherzer (1933 Abstracts, p. 458) is referred to. Authors' summary:—"The first part of this paper gives a mathematical theory of gas-focused cathode-ray beams discovered and investigated experimentally by Johnson, Buchta, Brüche and Ende under very low pressures (so that the positive ions and electrons can recombine practically on the walls of the discharge tube only) and with velocities of the order of several hundred volts. The distribution of charge over the cross section of the beam is shown to be uniform and to depend only on the distance travelled; this dependence leading, in the case of electrons of the same energy emerging under different angles from the same point, to the formation of beams with equidistant point-like nodes. It is shown further that such beams can exist only within a certain range of pressures, velocities and current densities, beyond which there is a sudden collapse of the phenomenon of gas-concentration.

"In the second part the theory is extended to the case of relatively high pressures (such that the recombination of the ions and of the secondary electrons takes place within the beam itself) and high velocities of the primary electrons. The results are very similar in every respect to those of part I. It becomes however necessary in this case to take into account the concentrating action of the magnetic field of the electron beam, which under certain conditions can become of primary importance, greatly extending the limit of stability of the beam in the region of high pressures. Unless we have to deal with electrons of very high speed, their motion requires in this case an accelerating electric field, which does not distort the general character of the phenomenon. These ideas seem to be applicable to the phenomenon of 'Schlauchentladung' (Seeliger) and to the electric spark at normal pressure."

Towards the end of the paper the writers point out that they have assumed the velocity of the electrons to be a single-valued function of their position. This leads to discrepancies between the theory and experiment: thus the nodes are never found to be point-like, and the nodeless cylindrical pencil is observed under conditions when the internodal distances should be, according to the theory, finite. These discrepancies are explained by the fact that the beam is due to a superposition of several beams of the elementary character investigated above. This superposition cannot be exact, since the fundamental equations are not linear; moreover, there is a large amount of arbitrariness in the conditions specifying the distribution of the primary electron velocities at different points of the beam.

ÜBER EIN NEUES SYSTEM ZUR VERWICKLICHUNG DER LINIENSTEUERUNGSMETHODE (On a New System applying the Line-Modulation [Velocity-Modulation] Method).—M. von Ardenne: Bedford and Puckle. (*Funktech. Monatshefte*, April, 1934, No. 4, Supp. pp. 15–19.)

An article on Bedford and Puckle's I.E.E. paper (May Abstracts, p. 275). The writer says that several reasons have prompted him to give a full summary of this paper: the thorough way in which the system has been worked out and the interesting manner in which the difficulties were overcome: the synchronisation over a single channel and without any rotating mechanism at either end: and the importance that just now, when the German industry is concentrating almost entirely on the intensity method of modulation, such promising results should have been obtained by a big English firm with the velocity modulation system. He lays particular stress on the advantages obtained by these workers by the addition of intensity modulation in order to obtain greater range of contrast.

A NEW METHOD OF REMOVING DISTORTIONS [Zero-Point Anomaly or Origin Distortion] DUE TO THE SPACE CHARGE IN GAS-FILLED CATHODE-RAY OSCILLOGRAPH TUBES.—M. von Ardenne. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 423–429.) *See* February Abstracts, p. 100.

DER DOPPELKATHODENSTRAHL-OSZILLOGRAPH UND SEINE ANWENDUNG ALS FERNSEHEMPFÄNGER (The Double-Ray Cathode-Ray Oscillograph and Its Use as Television Receiver).—F. W. Winckel: Schlesinger. (*Funktech. Monatshefte*, April, 1934, No. 4, Supp. pp. 21–22.)

See 1933 Abstracts, p. 168, l-h column. The application of Schlesinger's double tube to overcome the difficulty of band-width in high-quality television, by using two channels, and to colour television, is referred to, but no details are given.

On F. von Okolicsanyi's Note "A Method of Image Synthesis with Cathode-Ray Tubes."—R. Möller: Okolicsanyi. (*Funktech. Monatshefte*, April, 1934, No. 4, Supp. p. 22.)

Claims of Fernseh Company patents on the lines of Okolicsanyi's proposal (March Abstracts, p. 157). The latter replies.

Electrical Latent Image.—V. K. Zworykin. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, pp. 564–565: abstract only.)

"The paper deals with an apparatus [not described in the abstract] capable of storing electrically the information from an optical image projected on a sort of photoelectric mosaic and reproducing it at the desired moment."

Trichromatic Reproduction in Television.—J. C. Wilson: Baird Television Company. (*Electrician*, 11th May, 1934, Vol. 112, No. 2919, p. 624.)

Editorial on a Royal Society of Arts paper. The first part dealt with the Baird 1928 apparatus, in which only 15 lines were used: ". . . it seems evident that transmission of colour will require the use of 120 or even 180 lines, as in the case of the ultra-short wave monochromatic system recently demonstrated by the Baird Company. This will complicate matters at both ends, for the size of the scanning disc required to give the larger number of lines presents difficulties, and the use of a cathode-ray tube as a receiver would involve other modifications. It may, however, prove possible to adapt principles used in colour photography and coat the screen of the tube with trichromatic particles which would produce the desired result." For the first part of a long summary of the paper see *Television*, June, 1934, pp. 268, 270, 272.

Über die Plastik von Fernsehbildern bei Trägerfrequenzverstarkung ("Plastic" [Double Contours] in Television Images, due to Carrier-Frequency Amplification [and Its Elimination]).—E. Hudec. (*E.N.T.*, March, 1934, Vol. 11, No. 3, pp. 99–109.)

The formation of double contours is traced to two chief causes—the rectifying action of the photocell and the transient potentials occurring when the picture current passes through the amplifier. To avoid it, the amplifier stages must be so designed as to satisfy equation 3, where (using the notation of Fig. 5) $\omega^2_{\text{max.}} = (R_i + R_a)/R_i R_a R_g KC$. This can be done in various ways: the writer experimented with two amplifiers, both for an $\omega_{\text{max.}}$ of 1.92×10^6; in No.I this high value was obtained by reducing R_a, whereas in No. II the coupling condenser K was made very small. Comparative tests showed the great superiority of No.I as regards plastic (*see* Fig. 11b compared with 11a). In addition to the necessity for keeping the coupling condenser not too small, the desirability of steep-slope valves and of as small a number of stages as possible is shown; also the need of a small input capacity. Good results were obtained with an amplifier constructed on these principles for 180-line transmissions ($\omega_{\text{max.}} = 6.28 \times 10^6$), using Telefunken screen-grid valves; but since then Telefunken has brought out s.g. valves with steeper slope and smaller grid-cathode capacity, enabling the number of stages to be greatly reduced.

Optical Efficiencies and Detail in Television Systems. Part I. [Efficiencies of Aperture Disc, with Direct and Indirect Scanning: Relative Efficiencies of Aperture Disc, Lens Disc and Mirror Wheel: etc.].—(*Marconi Review*, March/April, 1934, No. 47, pp. 21–28.)

Aufbau des Bildes und Bildwirkung (The Structure of an Image and the Effect on the Eye).—R. Thun. (*Funktech. Monatshefte*, April, 1934, No. 4, Supp. pp. 13–15.)

The sharpest human eye can separate two objects (such as two stars in the sky) only if the angle subtended at the eye is at least 30″: for all except about 1% this angle must be twice as large, and for many people it must be over 2′. The writer works on a basis of 1.5′, taking the full sharpness of sight as constant over an angle of from 4° to 6°. Everything outside this angle is seen only vaguely, though the whole angle over which the image is "seen" amounts to about 150° (horizontally) or 130° (vertically). Satisfactory viewing of a film or television image is given if the picture angle does not exceed four times the full sharpness angle; *i.e.*, if it is not more than about 24°. He thus obtains formulae for the optimum picture dimensions for audiences of varying numbers, and discusses the fineness of image structure necessary to give good image quality from standard and narrow films and from television projectors. As regards the last, he arrives at the conclusion that from 120 to 180 lines should be satisfactory.

To obtain an idea as to what kinds of subject can be rendered satisfactorily with various numbers of lines, he has examined numerous pictures from illustrated journals; he finds that with 450 lines all these pictures, and with 180 lines about 84% of them, can be reproduced with sufficiently good quality.

Optimum Colour Combination for the Television Stage [with Photographic Evidence to confirm Visual Decisions].—E. B. Kurtz and R. R. Whipple. (*Journ. Television Soc.*, December, 1933, Series 2, Vol. 1, Part 9, pp. 291–293.)

Television at the 1933 Berlin Radio Exhibition.—E. H. Traub. (*Journ. Television Soc.*, December, 1933, Series 2, Vol. 1, Part 9, pp. 273–285.)

Television Transmissions [Times and Data of Berlin, Königswusterhausen, London and Rome Transmissions].—(*Funktech. Monatshefte*, April, 1934, No. 4, Supp. p. 24.)

Press Opinions on Television abroad.—(*Funktech. Monatshefte*, April, 1934, No. 4, Supp. pp. 22–23.)

Ultra-Short Waves and Their Application to Television [Elementary Considerations: the Suitability of the Catkin Valves].—R. W. Corkling. (*Journ. Television Soc.*, December, 1933, Series 2, Vol. 1, Part 9, pp. 286–287.)

Super-Regeneration [particularly for Ultra-Short-Wave Reception, 5 to 10 Metres].—Barden. (*See* under " Reception.")

Suggested Words for Sight-and-Sound Transmissions : " Telepresentation " and " Radiopresentation."—C. E. Martinato. (*L'Elettrotec.*, 5th May, 1934, Vol. 21, No. 13, p. 290.)

Television Abstracts : Notice to Abstractors : Subject Matter : List of Standard Abbreviations.—(*Journ. Television Soc.*, December, 1933, Series 2, Vol. 1, Part 9, pp. 310–311.)

Electro-Optics and Television [General Survey of Electro-Optical Effects, leading to comparison between Kerr and Electrostrictive Effects, and between Behaviour of Nitrobenzene and of Uni- and Bi-Axial Crystals : Converse Piezoelectric Effect : Rochelle Salt : Crystal Light Relays : Double-Image Polariscopes : etc.].—L. M. Myers. (*Journ. Television Soc.*, December, 1933, Series 2, Vol. 1, Part 9, pp. 294–309.)

Crystal Light Relays : the Modulation of Freely Oscillating and Damped Piezoelectric Crystals : a New Avenue of Research.—Myers. (*See* paper referred to above.)

In the Discussion following the paper reference was made to the writer's results in modulating oscillating crystals [" when the crystals are freely vibrating, their frequency/amplitude characteristic is very peaked and but little modulation in an undamped crystal can be expected. But if the crystal is successfully damped the range of modulation is, of course, increased. . . Up to the present it has been found possible to modulate the crystal up to 20 kc/s without appreciable attenuation at the higher frequencies, but such a device cannot be claimed as perfectly successful until it can be modulated up to at least 200 kc/s. The writer used 50–100 metre (quartz) crystals, 15 mm diameter "]. It was suggested that 120- or 180-line television would require a working frequency band approaching one million c/s : in reply to the question whether modulation with such a high frequency would be possible, the writer said he would normally consider 500 kc/s to be the highest frequency that could be applied successfully, but that by damping over a suitable series of peaks a wider response might be obtained. Regarding the suggested use of tourmalin he agreed that the higher fundamental frequency would be an advantage, but this would have to be considered in conjunction with the light absorption and the stress optical coefficients of the two crystals.

Illumination of Rarified Gases by High-Frequency Currents [50–150 Metres Wavelength].—F. Esclangon. (*Ann. de Physique*, March, 1934, Series 11, Vol. 1, pp. 267–406.)

The Light Modulation Characteristics of the Atmospheric-Pressure Mercury-Vapour Lamp [and of the Plane-Electrode Neon, Gas-Filled Incandescent, and Tungsten-Arc Lamps : in connection with Optical Telephony].—I. Yamamoto and K. Awaya. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548 : English summary pp. 28–31.) *Cf.* Suzuki, 1933 Abstracts, p. 231.

Nuove Ricerche sulla Produzione della Luce (New Researches on the Generation of Light [including the Sodium-Vapour Lamp for Television]).—M. Pirani. (*L'Elettrotec.*, 15th May, 1934, Vol. 21, No. 14, pp. 301–311.)

Glow-Discharge Photocells [Short Survey of Cells working in or near the Discharge Region : Theory, History and Patents].—P. Hatschek. (*Kinotech.*, No. 24, Vol. 15, 1934, pp. 399–401.)

Including the Karolus and Schröter cells (homogeneous field, grid), the Dunoyer type (hemispherical cathode, linear anode near glass wall), and the Patin type (strongly inhomogeneous field near anode). *See* also March Abstracts, p. 159, r-h column.

Spherical Cadmium Cells [Technique of Construction and Use].—Bender and Krüger. (*See* reference under " Propagation of Waves.")

On the Capacity Effect in Barrier-Layer Rectifiers and Photocells [Contradiction of Wood's Hypothesis of Resistance and Capacity Components variable with Frequency : the Existence of a Second Barrier Layer].—G. Liandrat : Wood. (*Journ. de Phys. et le Rad.*, February, 1934, Series 7, Vol. 5, No. 2, pp. 41–42 s.) *See* Wood, 1933 Abstracts, p. 631, l-h column : also next abstract.

Contribution to the Study of Barrier-Layer Photo-Elements. I.—G. Liandrat. (*Journ. de Phys. et le Rad.*, April, 1934, Series 7, Vol. 5, No. 4, pp. 179–183.)

Author's summary :—" The theories so far proposed to explain the functioning of barrier-layer photocells (copper oxide or selenium) have only had a moderate success. Experiment has only confirmed them in a qualitative or roughly quantitative manner. The reason for this, above all, is that the photo-conductive effect in the barrier layer has always been neglected. This effect is by no means negligible and would even play the principal rôle in certain cases (as in the ' colour effect ' found by Korosy and Selenyi—January Abstracts, p. 46) where a secondary rôle has been wrongly attributed to it. Another reason is that the verifications have been applied to selenium cells without any account being taken of the posterior dividing layer. The writer develops the calculation of the impedance of a system with two barrier layers in series, and discusses the experimental observations which confirm the existence of a second barrier layer." *See* also preceding abstract.

The Photoelectric Effect of Some Semi-Conducting Crystals. I. Argentite, Achantite, Cuprite : II. Proustite, Pyrargyrite, Bournonite, Molybdenite.—G. Athanasiu. (*Journ. de Phys. et le Rad.*, February and March, 1934, Series 7, Vol. 5, Nos. 2 and 3, pp. 85–94 and 132–140.)

The Dependence of the Dark Conductivity of Selenium on the Temperature [obeying the Van t'Hoff Formula].—P. Scharawsky. (*Physik. Zeitschr. der Sowietunion*, No. 3, Vol. 5, 1934, pp. 511–515 : in German.)

The Mechanism of the Action of Light on Electrolytic Selenium Photocells.—R. Audubert and J. Roulleau. (*Comptes Rendus*, 23rd April, 1934, Vol. 198, No.17, pp. 1489–1490.)

Previous work by the first writer (1933 Abstracts, p. 455, l-h col.) has shown that in almost every case the Becquerel effect demands the presence of water: this led to the photoelectro-chemical theory based on the hypothesis of the photolysis of water under the action of the light. The writers have now examined the behaviour of selenium-on-platinum electrodes, to see whether the action of light on these is photoelectro-chemical or electronic. They find that with these electrodes the presence of water is no longer essential; that the behaviour to oxidising and reducing components in the electrolyte is the reverse of that demanded by the photoelectro-chemical theory; and that although the photo-potential varies (within certain limits) with the light intensity according to a logarithmic formula similar to that of the theory, the coefficient of proportionality is no longer constant. It is therefore concluded that the mechanism is electronic.

Relation between the Curve of Special Sensitivity and the Curve of Absorption in "Colouring Matter" Photocells.—C. Stora. (*Comptes Rendus*, 14th May, 1934, Vol. 198, No. 20, pp. 1763–1765.)

The writer has shown that a thin strip of any pure metal, coated with a film of colouring matter, forms a photo-sensitive electrode (1933 Abstracts, p. 455, r-h column). The present researches, proving the identity of the spectral sensitivity and absorption curves, show that the photo-sensitive layer is composed of a very thin film of the colouring matter and that it is the energy absorbed by this which is responsible for the variation of potential under the action of light.

The Marconi System of Facsimile Telegraphy [Latest Equipment, for Black-and-White and Half-Tone Subjects, Photographs, etc.]—J. W. Eastman and J. F. Hatch. (*Marconi Review*, March/April, 1934, No. 47, pp. 1–12.)

Simultaneous Transmission of Telegrams and Pictures on One Radio Channel, by Changing Periodicity and Changing Amplitude of Modulating Frequency.—Telefunken: Schröter. (German Pat. 540 850, pub. 5.1.1934.)

The picture signals are represented by the changing amplitude, while the periodicity, alternating between two values, controls the printing telegraph receiver.

Mechanical Recording of Electrical Picture Currents [and the Use of a Blunt-Angled Cutting Tool giving Width-of-Cut Variations much greater than Impressed Movement normal to Plane of Material].—Philips Company. (French Pat. 759 277, pub. 31.1.1934: *Rev. Gén. de l'Élec.*, 28th April, 1934, Vol. 35, No. 17, pp. 133–134 D.)

"Plastic" Films [Stereoscopic Projection].—A. Neuburger: Ives. (*Funktech. Monatshefte*, April, 1934, No. 4, Supp. pp. 20–21.)

Increase of Sensitivity of Photographic Plate [by Combination with Photoelectric Film].—K. O. Kiepenheuer. (*Naturwiss.*, 11th May, 1934, Vol. 22, No. 19, p. 297.)

MEASUREMENTS AND STANDARDS

Berechnung des hochfrequenten Feldes eines Kreiszylinderspule in einer konzentrischen leitenden Schirmhülle mit ebenen Deckeln (The Calculation of the H.F. Field of a Cylindrical Coil in a Concentric Conducting Screening Cover with Flat Ends).—M. J. O. Strutt. (*Hochf:tech. u. Elek:akus.*, April, 1934, Vol. 43, No. 4, pp. 121–123.)

In addition to the assumption of dimensions small in comparison with the wavelength, it is assumed that the magnetic lines of force at the inner surface of the cover run parallel to this surface. This is sufficiently true at high frequencies: it would be strictly true at any frequency if the material were infinitely conducting, and since conductivity and frequency enter into the formulae as a product, the finite conductivity of the actual cover behaves, for the high frequencies considered, like an infinite conductivity at low frequencies.

On this assumption, the field outside the coil is represented by the Laplace potential equation: by the use of Green's function an exact solution is obtained for any desired shape of coil. A series is arrived at (equation 17a) which is so rapidly convergent that in many practical cases three terms are enough to give the inductance within 1%. The coil losses can also be calculated. For papers by Hillers and by Hayman *see* Abstracts, 1933, p. 281, and June, p. 332, r-h col.

Empirical Formulae for the Calculation of the Coefficients of Self Inductance [including a Correction to Janet's Formula for Multi-Layer Coils].—M. Mathieu. (*Bull. de la Soc. franç. des Élec.*, May, 1934, Series 5, Vol. 4, No. 41, pp. 445–456.)

On the Design of a Standard Self-Inductance [Mathematical Investigation of a Single-Layer Enamelled Copper Wire Coil on a Quartz Cylinder: the Deformation of the Wire's Circular Cross Section on conversion from Straight Cylinder into a Helix, and the Effect of Expansion due to Temperature Rise].—L. Roy. (*Comptes Rendus*, 23rd April, 1934, Vol. 198, No. 17, pp. 1465–1468.)

The Measurement of Impedance [and Its Reactive and Resistive Components: Easy Method accurate to about 0.5%, based on Comparison of Voltages between Various Points of Ordinary Four-Arm Net: No "Balances"].—N. F. Astbury. (*Journ. I.E.E.*, May, 1934, Vol. 74, No. 449, pp. 445–447.)

Induttometro elettrodinamico a Lettura diretta (The Direct-Reading Measurement of Inductance by means of the Electro-Dynamometer [with Secondary Coils fed inductively from Primary Circuit: Results independent of Supply Voltage and Frequency and of Circuit Resistance]).—G. Rutelli and G. Sacerdote. (*Alta Frequenza*, February, 1934, Vol. 3, No. 1, pp. 20–32.)

ANTENNA MEASURING SET [for measuring Resistive and Reactive Components of Antenna and Transmission Line Impedance, and the Terminating Impedance at Antenna-End of Transmission Line].—W. B. Lodge. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 14–16.)

THE STANDARDS OF CAPACITANCE AT THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT.—Giebe and Zickner. (*E.T.Z.*, 3rd May, 1934, Vol. 55, No. 18, p. 448.)

Summary of three papers, the first of which was referred to in 1933 Abstracts, p. 338, r-h col. The summary includes the diagram of a rotating condenser giving a true zero capacity at the scale zero.

ABSOLUTE MEASUREMENT OF CAPACITY BY MAXWELL'S BRIDGE METHOD.—R. Yoneda and K. Yamaguchi. (*Res. of Electrot. Lab., Tokyo*, October, 1933, No. 355: 53 pp.)

"It is shown that an air condenser having a capacity of approximately 0.1 μF can be evaluated in terms of resistance and time with an accuracy of 0.001%, if the correction for the 'zero shift' is applied, and that the Maxwell's bridge is very suitable for this purpose."

CAPACITY CONSTANCY OF HIGH-FREQUENCY RESISTANCES USED IN THE EXACT MEASUREMENT OF CAPACITY AT HIGH FREQUENCIES.—Graffunder. (*See* abstract under "Subsidiary Apparatus and Materials.")

RESISTENZE NEGATIVE DI TUBI ELETTRONICI E LORO MISURA (The Negative Resistances of Electronic Tubes, and Their Measurement [including a New Method giving Direct Reading on Ordinary Decade Resistance Box: Low Negative Resistances obtained with Pentodes]).—A. Pinciroli. (*Alta Frequenza*, February, 1934, Vol. 3, No. 1, pp. 5–19.)

SOME EXPERIMENTS WITH PURE-METAL RESISTANCE STANDARDS.—J. L. Thomas. (*Bur. of Stds. Journ. of Res.*, March, 1934, Vol. 12, No. 3, pp. 313–321.)

THE SUITABILITY OF ELECTRODYNAMIC CURRENT METERS FOR USE IN AUDIO-FREQUENCY MEASUREMENTS.—Hölzler. (*See* under "Acoustics and Audio-Frequencies.")

A COMPENSATED THERMIONIC ELECTROMETER.—K. G. Compton and H. E. Haring. (*Trans. Electrochem Soc.*, 1932, Vol. 52, pp. 345–356: *Bell Tel. Syst. Techn. Pub.*, Monograph B-780.)

VACUUM TUBES FOR MEASURING VERY SMALL CURRENTS AND POTENTIALS [Special Electrometer Space-Charge Tetrode with Input Resistance Control-Grid/Filament as high as 10^{16} Ohms: Mazda UX-54].—S. Hamada. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, pp. 209–216.)

THE MEASUREMENT OF HARMONIC POWER OUTPUT OF A RADIO TRANSMITTER [Power delivered to Aerial measured instead of Harmonic Field Strengths at Specified Locations: Comparison Method].—P. N. Honnell and E. B. Ferrell. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, p. 548: short summary only.)

SOME APPLICATIONS OF AN A.C. VALVE BRIDGE [as a Modulator in Suppressed Carrier System: Addendum].—M. Reed. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, p. 254.) Addition to the writer's paper referred to in June Abstracts, p. 333, r-h column.

A PRACTICAL TEST METHOD OF MEASURING THE STRENGTH OF INTERFERENCE WITH BROADCAST RECEPTION.—Conrad and Reppisch. (*See* under "Reception.")

THE DESIGN AND TESTING OF MULTI-RANGE RECEIVERS [and a Useful "Piston" Attenuator].—Harnett and Case. (*See* under "Reception.")

A COMMON SOURCE OF ERROR IN MEASUREMENTS OF RECEIVER SELECTIVITY.—Dingley. (*See* under "Reception.")

THE TESTING OF FREQUENCY MONITORS FOR THE FEDERAL RADIO COMMISSION.—W. D. George. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 449–456.)

ON THE PENTODE CRYSTAL OSCILLATOR [superior to Triode in Power Output at Equal Voltages: Less Load on Crystal: recommended for Master Oscillators].—K. Hatakeyama and K. Nakanishi. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts p. 17.)

THE CIRCLE DIAGRAMS OF THE QUARTZ OSCILLATOR.—R. Usui. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, pp. 201–213: long English summary pp. 21–24.)

"Thus many quantitative studies on crystal oscillators can be handled very easily; otherwise, they are very complicated, and sometimes almost impossible to be handled." Both grid/filament and plate/grid connections are dealt with.

ON THE FREQUENCIES, AND THEIR TEMPERATURE COEFFICIENTS, OF THE VIBRATIONS OF QUARTZ PLATES.—I. Koga and N. Takagi. (*Journ. I.E.E. Japan*, March, 1934, Vol. 54 [No. 3], No. 548, p. 242: in Japanese.)

DIRECT-READING 1/1 000 SECOND CHRONOMETER, *and* A NEW POTENTIOMETER FOR MEASURING VERY SHORT TIME INTERVALS [around One Millisecond].—Ikebe: Ikebe and Isobe. (*Jap. Journ. of Physics*, 28th Feb. 1934, Vol. 9, No. 1, Abstracts p. 1.)

ÜBER ABSORPTIONSMESSUNGEN IN FLÜSSIGKEITEN IM GEBIET KURZER ELEKTRISCHER WELLEN. II (Absorption Measurements in Liquids in the Region of Short Electric Waves. II).—J. Malsch. (*Ann. der Physik*, April, 1934, Series 5, Vol. 19, No. 7, pp. 707–720.)

For reference to Part I ***see*** 1932 Abstracts, p. 474: *cf.* also p. 298. The present paper gives a critical discussion of many recent papers on the subject of the absorption of ultra-short waves in liquids (mostly alcohols); the writer arrives at the conclusion that some of the experimental results obtained cannot be explained on the basis of any existing theory of anomalous dispersion.

Messung der Dielektrizitätskonstanten chemisch definierter Körper (Measurement of the Dielectric Constants of Chemically Defined Substances).—F. Keller and W. R. Lehmann. (*Zeitschr. für Physik*, 1934, Vol. 88, No. 9/10, pp. 677–682.)

The methods employed were that in which the substance is used in a mixture and that in which it is made into a compressed powder and used to fill a specially made condenser. Measured dielectric constants of many chemical compounds are given.

Researches on Electrical Beats [and Their Stabilisation]: Application to the Study of Dielectric Constants.—A. Hée. (*Journ. de Phys. et le Rad.*, February, 1934, Series 7, Vol. 5, No. 2, pp. 24–25 s.)

British Standard Graphical Symbols for Telephony, Telegraphy and Radio Communication. (*Specification No.* 530—1934 of British Standards Institution: 35 pp.)

SUBSIDIARY APPARATUS AND MATERIALS

The Classes of Practically Useful Symmetrical T and Π Filter Circuits.—Grünwald. (*See* under "Properties of Circuits.")

Attenuators and Correcting Circuits.—Rappis. (*See* under "Properties of Circuits.")

The Measurement of Attenuation in Receiver Devices for Eliminating Mains Noises.—Schütte and Weiss. (*See* under "Reception.")

The German Post Office's Feed-Back Suppressor for Duplex Wireless Telephonic Services.—Rücklin. (*See* under "Stations, Design and Operation.")

The Cathode-Ray Oscillograph: Recording Methods and Circuits for Periodic Processes. IV.—The Measurement of Permeability, Dielectric Constant, and Magnetic and Dielectric Loss.—M. Knoll and W. Kleen. (*Archiv f. tech. Messen*, No 31, Vol. 3, 1934, pp. J 834 onwards.)

The Cathode-Ray Oscillograph in Speech Recording and Analysis [Continuous-Film Records at Speeds of 6ft/sec. using Deep-Blue-Response Screen and Moving-Film or Drum Camera].—R. Curry. (*Journ. Scient. Instr.*, May, 1934, Vol. 11, No. 5, pp. 162–164.)

Cathode-Ray Tubes: New Types and Their Applications.—RCA Radiotron Company. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 17 and 26.)

External Recording with the Cathode-Ray Oscillograph.—B. von Borries. (*Thesis*, Berlin, 1933: at Patent Office Library, London.)

On the Theory of the Gas-Focused Cathode-Ray Beams.—Frenkel and Bobkovsky. (*See* under "Phototelegraphy and Television.")

Magnetic Refocusing of Electron Paths.—W. E. Stephens. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, pp. 513–518.)

The theory of the effect on electron beams of wedge-shaped magnetic fields is worked out. It is found that if the lines of force are perpendicular to the plane of motion of a beam, which enters the magnetic field perpendicular to one edge and is of such a strength that it will leave the field perpendicular to the other edge, the refocusing of slightly divergent electron paths will occur. "The position of best refocusing is on a line through the point of divergence of the electron beam and the apex of the wedge field." The theoretical results have been checked experimentally in a particular case.

The Development of High-Voltage Ionic Tubes of High Power, especially for Cathode-Ray Oscillographs.—H. Knoblauch. (*Thesis*, Berlin, 1933: at Patent Office Library, London.)

Power Supply and Linear Time Axis [with Pentode as Current Limiter] for Cathode-Ray Oscillographs.—W. L. Meier and P. A. Richards. (*Electronics*, April, 1934, pp. 110–112.)

On the Luminescence by Cathode Rays. I.—A Study of Chromium and Other Elements as Activators for Aluminium Oxide.—S. Izawa. (*Jap. Journ. of Phys.*, 28th Feb. 1934, Vol. 9, No. 1, Abstracts p. 40.)

Increase of Sensitivity of Photographic Plate [by Combination with Photoelectric Film].—K. O. Kiepenheuer. (*Naturwiss.*, 11th May, 1934, Vol. 22, No. 19, p. 297.)

A Relay Memory for a Thyratron Counter [used for Alternate Comparative Counts of Alpha Particles under Two Different Sets of Experimental Conditions].—C. E. Wynn-Williams. (*Proc. Phys. Soc.*, 1st May, 1934, Vol. 46, Part 3, No. 254, pp. 303–311.)

Shield-Grid Thyratrons [Only Disadvantages are Slight Increase in Cost, Extra Connection for Grid, Slightly Greater Size: Numerous Advantages].—O. W. Livingstone and H. T. Maser. (*Electronics*, April, 1934, pp. 114–116.)

Laboratory Applications of Kathetrons [Grid Controlled, Mercury-Vapour Rectifiers used for Voltage Regulation, Time Delay, etc.]—P. H. Craig. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 563: abstract only.)

Method of Momentary Reduction of Voltage delivered by Series Mercury-Vapour Rectifier Groups used for Broadcasting Transmitter Supply, during Heating-Up of Valves.—Brown Boveri Company. (French Pat. 759 285, pub. 31.1.1934: *Rev. Gén. de l'Élec.*, 28th April, 1934, Vol. 35, No. 17, p. 134 D.)

Influence of Gases on the Unilateral Conductivity of the Silicon/Carbon [Rectifier] Couple.—M. Quintin. (*Comptes Rendus*, 7th May, 1934, Vol. 198, No. 19, pp. 1677–1679.)

This rectifying couple has a characteristic represented, for each branch, by the parabolic relation $i = ae^2 + be$, where i is the current strength and e the applied voltage: theoretically, this relation can be explained on the hypothesis of ionisation phenomena due, in part at least, to the presence of occluded gases in the contact layer, the dissymmetry of the two branches depending on the difference of the mobilities of the ions formed: *see* 1929 Abstracts, p. 226 (two).

The researches now reported, on the influence of the surrounding gas, were undertaken to check this hypothesis. It was shown that the nature and the pressure of the gas diffusing in the barrier layer do actually influence the unilateral conductivity. The results are extremely complex, and although the existence of an optimum pressure suggests the action of gaseous ionisation, it is pointed out that in the hypothesis of a strictly electronic mechanism the pressure and nature of the gas might play a part, by modifying the barrier layer, which, as the writer has shown (May Abstracts, p. 281, l-h col.), may be of a gaseous nature.

On the Capacity Effect in Barrier-Layer Rectifiers and Photocells.—Liandrat: Wood. (*See* under "Phototelegraphy and Television.")

The "Sirutor" Cartridge-Type Dry-Plate Rectifier.—Siemens Company. (*See* under "Reception.")

On the Cuprous Oxide Rectifier [D.C. Output Potential established as Proportional to Square of A.C. Input Potential when No D.C. Current passes: etc.].—T. Asada. (*Jap. Journ. of Physics*, 28th Feb. 1934, Vol. 9, No. 1, pp. 1–25.)

The Dry Accumulator with Tin Plates [particularly Suitable for Small H.T. Batteries, Flash-Lamps, etc.].—Ch. Féry. (*Journ. de Phys. et le Rad.*, April, 1934, Series 7, Vol. 5, No. 4, pp. 70–72 s.)

The Calculation of Circuits containing Thyrite [for Lightning Protection, across Contacts to prevent Sparking, Voltage or Current Regulation, etc.].—T. Brownlee. (*See* under "Atmospherics and Atmospheric Electricity.")

Portable Detector for Radium [for Tracing Lost Radium Preparations: Ionisation Chamber, 2-Valve Amplifier and Microammeter].—L. F Curtiss. (*Bur. of Stds. Journ. of Res.*, March, 1934, Vol. 12, No. 3, pp. 379–382.)

Multiplication of a Frequency by Simple Fractional Numbers.—Longo. (*See* under "Properties of Circuits.")

Some Applications of Amplitude-Dependent Resistances and Amplifiers.—W. Nestel. (*Thesis*, Bückeburg, 1933, 72 pp: at Patent Office Library, London.)

[Constancy of Capacity of] High Frequency Resistances.—W. Graffunder. (*Ann. der Physik*, April, 1934, Series 5, Vol. 19, No. 7, pp. 689–706.)

This paper deals with resistances used in circuits for the exact measurement of capacity at high frequencies. The resistances considered are connected in parallel with condensers and, when they are exchanged or adjusted, variations of their inductance and capacity may cause considerable errors in the capacity measurement. The degree of constancy of the capacity of a number of high-frequency resistances was investigated by a beat method, for which platinum resistances, produced by cathode sputtering, were used as standards of comparison. "Dralowid" and "Silit" resistances showed large capacity fluctuations. The capacity of liquid resistances depends on the magnitude of the polarisation effect at the electrodes. The influence of polarisation may be decreased by using large electrodes, covered with platinum black. Liquid resistances must however always be compared with fixed resistances for exact measurements.

Winding and Adjusting Resistance Coils.—D. C. Gall. (*Journ. Scient. Instr.*, May, 1934, Vol. 11, No. 5, pp. 137–144.)

Fluctuations of Resistance in a Metallic Conductor of Small Volume [Thermal Agitation Phenomena in a Very Thin Metallic Film increased by Passage of Direct Current].—Bernamont. (*See* under "Valves and Thermionics.")

Fuse Arrangements for Small Currents in Testing Circuits [Fusible Cut-Outs unsatisfactory for Currents under 10 mA: Two Satisfactory Valve Devices].—Heinrich-Hertz Institute. (*E.T.Z.*, 19th and 26th April, 1934, Vol. 55, Nos. 16 and 17, pp. 391–393 and 417–420.)

Moerder's triode device (1932 Abstracts, p. 478, l-h col.) has the necessary sensitivity ($10^{-3} - 10^{-6}$ A) and is practically free from inertia; but it has a high resistance ($10^4 - 10^7$ ohms) and only works for d.c. in one direction. The two arrangements here described are free from these objections.

In the first, the valve is used in a "kipp" connection: for d.c., in the form of a retroactive 2-valve amplifier such as the "Kallirotron": for a.c., in the form of a single-valve circuit with strong retroaction and high negative bias: in either case the sudden production of oscillation breaks the protected circuit by a relay or by melting a fuse. The second arrangement acts as a safety shunt, and consists of two rectifier valves in push-pull, or a single valve with two anodes: it is only suitable for alternating currents, but this was no objection for its particular purpose, which was the protection of sensitive thermo-junctions: these are not used for direct currents, and the circuit is particularly suitable for the purpose owing to its very small consumption of energy.

The Calculation of the H.F. Field of a Cylindrical Coil in a Concentric Conducting Screening Cover with Flat Ends.—Strutt. (*See* under "Measurements and Standards.")

Testing Station for Corrosion by Sea and Ozone [on Mud Flats of Mersea Island].—(*Journ. Scient. Instr.*, May, 1934, Vol. 11, No. 5, pp. 171–172.)

Plastic Workshop Materials [including Many of the New Insulating Materials].—H. Bürgel. (*Zeitschr. V.D.I.*, 28th April, 1934, Vol. 78, No. 17, pp. 519–522.)

Achievements of the German Electro-Ceramic Industry [including Frequentit, Calan and other Insulating Materials].—J. Wallich. (*Ibid.*, pp. 522–524.)

The Properties of Thin Oil-Impregnated Paper.—R. Guthmann. (*E.T.Z.*, 12th April, 1934, Vol. 55, No. 15, pp. 364–366.)

New Methods of Drying-Out Insulating Oil.—P. Tinelli. (*L'Elettrotec.*, 25th April, 1934, Vol. 21, No. 12, pp. 265–267.)

Influence of Wave-Form in Dielectric Tests.—B. L. Goodlet. (*Journ. I.E.E.*, May, 1934, Vol. 74, No. 449, pp. 384–386.) In a paper on "Electromagnetic Phenomena in High-Voltage Testing Equipment," followed by several Discussions.

Robust Logarithmic Variable Condenser avoiding Exaggerated Plate Shapes by varying Number of Plates engaged.—Griffiths. (*See* abstract under "Acoustics and Audio-frequencies.")

Hoges-Calit Condensers [up to 200 cms Capacity] and Calit-Mica Condensers [up to 50 000 cms].—(*Radio, B., F. für Alle*, March, 1934, No. 3, p. 48.)

The Use of the Water-Jet Microphone for Observing and Recording Noises, Vibrations, Geiger Counter Impulses, etc.—H. Greinacher. (*Helvet. Phys. Acta*, Fasc. 3, Vol. 7, 1934, pp. 360–367.) In a paper entitled "A Hydraulic Counter for Elementary Rays": see also Abstracts, 1930, p. 647, l-h column, and 1932, p. 351, r-h column.

STATIONS, DESIGN AND OPERATION

High Quality Radio Broadcast Transmission and Reception.—Ballantine. (*See* under "Transmission.")

The Lorenz Network of Common-Wave Broadcasting Stations in Germany.—Arendt. (*See* abstract under "Transmission.")

Synchronisation of Independent Common-Wave Transmitters by Phase-Sensitive Devices.—Telefunken. (*See* under "Transmission.")

Annual Tube Replacement Cost for Broadcasting Stations.—(*Electronics*, April, 1934, p. 113.)

Rundfunk-Geografie (Broadcasting Geography [Charts showing Quality of Reception, in Germany and Neighbouring Countries, from Various Broadcasting Stations]).—(*Die Sendung*, 25th May, 1934, Vol. 11, No. 22, p. 426: one of a series.)

Broadcasting over the Supply Mains.—(*Electrician*, 20th April, 1934, Vol. 112, No. 2916, p. 526.) Summary of House of Commons discussion of proposed clause in Electricity (Supply) Bill.

New Organisation of Broadcast Programmes in France.—J. C. de Fabel. (*Génie Civil*, 26th May, 1934, Vol. 104, No. 21, pp. 470–471.)

League of Nations Wireless Station [Purpose, Administrative Control, and Equipment].—G. F. Van Dissel. (*Proc. Inst. Rad. Eng.*, April, 1934, Vol. 22, No. 4, pp. 430–448.)

North Atlantic Ship-Shore Radiotelephone Transmission during 1932/1933.—Anderson. (*See* under "Propagation of Waves.")

A System of Wireless Secret Telephony.—Chiba. (*See* under "Transmission.")

Knoxville Police Radio System [on 2 474 kc/s].—M. O. Sharpe. (*Rad. Engineering*, April, 1934, Vol. 14, No. 4, pp. 18–21.)

Radiotelephony with an Ultra-Short [Micro-] Wave of 18 cm [over about 1 km, with Paraboloid Copper-Plate Mirrors].—K. Morita and Y. Degawa. (*Rep. of Rad. Res. in Japan*, December, 1933, Vol. 3, No. 3, Abstracts p. 24.)

Die Rückkopplungssperre für die drahtlosen Gegensprechverbindungen der Deutschen Reichspost (The German Post Office's Feed-Back Suppressor for Duplex Wireless Telephonic Services).—R. Rücklin. (*E.N.T.*, March, 1934, Vol. 11, No. 3, pp. 75–92.)

GENERAL PHYSICAL ARTICLES

Discontinuities on Reversal of Electrification [of various Dielectrics: analogous to Barkhausen Effect].—H. Schönfeld. (*Ann. der Physik*, April, 1934, Series 5, Vol. 19, No. 7, pp. 733–758.)

Continuation of former work on the electrical Barkhausen effect in Rochelle salt (1933 Abstracts, p. 287, l-h column). This paper describes the effect of altering continuously the field strength in various dielectrics through zero to the same numerical value with the opposite sign, when, in addition to the continuous variation of surface charge, a discontinuous change is also found to occur, in analogy to the Barkhausen effect.

Experimental Demonstration of the Vibratory Movement [in addition to Brownian Movement] of Physical Molecules [Very Small Silver Crystals suspended in a Liquid].—U. Schmieschek. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 15, 1934, pp. 178–180.)

On the Theory of the Brownian Movement: the Distribution of Velocities.—G. Krutkow. (*Physik. Zeitschr. der Sowietunion*, No. 2, Vol. 5, 1934, pp. 287–300.)

Dipole Moment and the Dielectric Constant of the Solvent [Experiments on Various Organic Solvents].—H. Müller. (*Physik. Zeitschr.*, 15th April, 1934, Vol. 35, No. 8, pp. 346–349.)

The Physical Properties of the Positive Electron : Electrostatic Deviation and Specific Charge : Annihilation of the Positive Electrons and Radiation of Dematerialisation.—J. Thibaud. (*Journ. de Phys. et le Rad.*, January, 1934, Series 7, Vol. 5, No. 1, pp. 10–11 s.)

On the Connection between the Motion of Electrical Charges and the Propagation of Waves.—F. Prunier. (*Rev. Gén. de l'Élec.*, 28th April, 1934, Vol. 35, No. 17, pp. 559–566.) Continuing the work referred to in 1933 Abstracts, p. 639 (three).

The Value of *e*/*m* [Discussion of Recent Work on the Subject].—R. T. Birge. (*Nature*, 28th April, 1934, Vol. 133, p. 648.)

Electric Discharges in Gases. II. Ions in Dense Gases.—K. K. Darrow. (*Elec. Engineering*, March, 1934, Vol. 53, No. 3, pp. 388–395.) For the article by Tonks and that by Slepian and Mason see February and April issues.

"Stepped" and "Stepless" Discharge [and a Comparison with Krug's Results].—K. Buss: Krug. (*Archiv f. Elektrot.*, 5th April, 1934, Vol. 28, No. 4, pp. 206–210.) For Krug's work *see* 1932 Abstracts, p. 658, l-h column.

Magnetic Refocusing of Electron Paths.—Stephens. (*See* under "Subsidiary Apparatus and Materials.")

The Temperature Radiation of Incandescent Oxides and Oxide Mixtures in the Infra-Red Spectrum.—G. Ritzow. (*Ann. der Physik*, April, 1934, Series 5, Vol. 19, No. 7, pp. 769–799.)

The Explanation of Supraconductivity [Preliminary Note proposing Infinite Dielectric Constant with Finite Conductivity as Description of Supraconductive State).—J. Frenkel. (*Nature*, 12th May, 1934, Vol. 133, pp. 730–731.)

MISCELLANEOUS

Note on Integrals of Products of Experimentally Determined Magnitudes [given by Simple Sum of Products for Uniformly Distributed Values of Variable].—T. Smith. (*Proc. Phys. Soc.*, 1st May, 1934, Vol. 46, Part 3, No. 254, pp. 365–371.)

The Application of the Theory of Probability to Engineering Projects.—W. Kummer. (*Rev. Gén. de l'Élec.*, 21st April, 1934, Vol. 35, No. 16, p. 526: summary only.)

A Method for the Solution of Oscillation Problems by Matrices.—W. J. Duncan and A. R. Collar. (*Phil. Mag.*, May, 1934, Series 7, Vol. 17, No. 115, pp. 865–909.)

This paper describes an arithmetical process, with greatly reduced labour, for solving a large class of problems on the oscillations of dynamical systems containing no dissipative forces. The frequencies of the overtones can be successively determined. [The method depends fundamentally on the theory of quadratic forms and could thus be applied to deal with electromagnetic systems].

Regarding Observations on the Terminology in New Discoveries [and particularly the Significance of the Termination "tron" and "on"].—J. B. Pomey: Blondel. (*Rev. Gén. de l'Élec.*, 24th March, 1934, Vol. 35, No. 12, pp. 377–378.) Prompted by Blondel's remarks (March Abstracts, p. 167, r-h column).

"International Telephonic Vocabulary in Seven Languages" [Book Review].—C.C.I.F. (*E.N.T.*, March, 1934, Vol. 11, No. 3, p. 109.)

"Principles of Radio" [Book Review].—K. Henney. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, p. 258.)

Twenty Years of Amateur Radio : the History and Achievements of the American Radio Relay League.—C. B. De Soto. (*QST*, May, 1934, Vol. 18, No. 5, pp. 20–26.) Among other topical articles in the Twentieth Anniversary issue.

Radio Novelties at the Leipzig Spring Fair, 1934.—J. Gross. (*Radio, B., F. für Alle*, May, 1934, No. 147, pp. 65–68.)

Including the Telefunken "auto" receiver (4-valve hexode superhet. with heating current from starter battery and anode supply from same source by means of a vibrating transformer) : the Owin receivers with "parabolic" scales : the Dralowid wave-trap with inductance variable by means of a slightly tapered coil adjustable over a tapered pot-magnet core of the new "Draloperm" material, and fixed condenser using "Kerafat" with s.i.c. of 70 to 100 : the new h.f. magnetic material "Ferropress" : and the Jahre Company's "d.c. transformer" using the principle of charging condensers in parallel and discharging in series, by means of vibrating contacts.

French Physical Society's Annual Exhibition, 1934 [including Photoelectric and Piezoelectric Devices, Thermoelectric Distant Control Apparatus, etc.].—(*Rev. Gén. de l'Élec.*, 28th April, 1934, Vol. 35, No. 17, pp. 553–557.)

Among the piezoelectric instruments mentioned are those for recording arterial-pressure curves (Langevin - Gomez), locomotive - axle pressures (Langevin-Mauzin), steam and internal-combustion engine pressures, and surges in water mains (Langevin-Hocart).

Conclusions from Piezoelectric Investigations of the Pressures in Internal Combustion Engines.—M. Serruys. (*Comptes Rendus*, No. 22, Vol. 197, 1933, pp. 1296–1298.)

A Simple High-Frequency Method of Measuring Small Movements [Ultra-Micrometer using Retroactive Coupling Change in Huth-Kühn Oscillator].—W. Fricke. (*Hochf:tech. u. Elek:akus.*, May, 1934, Vol. 43, No. 5, pp. 149–151.)

In the Huth-Kühn oscillator, under suitable conditions, a very small change in either the anode or grid tuned circuit causes a large change in the retroaction coupling factor and consequently in the amplitude of the oscillations and the size of the grid current (which is used as the indicator). The practical circuit is shown in Fig. 3: for reasons given, the measuring condenser is in the anode tuned circuit, in parallel with a small adjustable condenser. The oscillator wavelength is 85.69 m, the natural wavelengths of grid and anode circuits being 84.88 and 83.44 m respectively. The Huth-Kühn circuit has such a good frequency stability that the arrangement can be driven off the mains with the help of Stabilisators. A portable equipment has been used successfully in the paper-making industry.

The Detection and Measurement of the Longitudinal Curvature of Small Surfaces of Any Cross-Section [Application to Examination of Fine Wires, Curvature of Small Coils, etc., of Method developed for Gramophone-Record Sound Tracks].—H. E. Gauss. (*Journ. Scient. Instr.*, May, 1934, Vol. 11, No. 5, pp. 157–162.)

Bridge Method of Testing Welds.—J. R. Batcheller. (*E.T.Z.*, 17th May, 1934, Vol. 55, No. 20, p. 495.) Long summary only: *see* also March Abstracts, p. 168, l-h column.

The Recording of Small Capacity Changes with the Help of a Bridge Arrangement.—H. F. Nissen. (*Archiv f. tech. Messen*, No. 31, Vol. 3, 1934, pp. v 3531–2.)

Thyratron/Variable-Reactor Control in Rubber Manufacture [Synchronisation between Extension-Mill Output and Conveyor].—(*World Power*, May, 1934, Vol. 21, No. 125, p. 232: *Electronics*, April, 1934, p. 118.)

Electricity Meter using Thermionic Valve and eliminating Rotating System.—J. Maurer. (French Pat. 759 119, pub. 29.1.1934: *Rev. Gén. de l'Élec.*, 28th April, 1934, Vol. 35, No. 17, p. 133 D.)

Blinking Light for Level-Crossing Signal [Gaseous Discharge Tube with Shunted Condenser Circuit, driven by Dry-Cell Battery: "Atna" Apparatus].—J. Thomas. (*Génie Civil*, 5th May, 1934, Vol. 104, No. 18, pp. 406–407.)

The Self-Control of Mechanical Oscillation Systems by Retroaction.—W. Späth. (*E.T.Z.*, 10th May, 1934, Vol. 55, No. 19, pp. 465–467.)

The Light Modulation Characteristics of the Atmospheric-Pressure Mercury-Vapour Lamp [and of the Plane-Electrode Neon, Gas-Filled Incandescent, and Tungsten-Arc Lamps: in connection with Optical Telephony].—I. Yamamoto and K. Awaya. (*See* under "Phototelegraphy and Television.")

Investigations on the Action of a High-Frequency X-Ray Equipment [fed by a Tesla Transformer: Advantages over Low-Frequency Equipments].—W. Heyde and E. Saupe. (*Physik. Ber.*, 15th April, 1934, Vol. 15, No. 8, pp. 619–620.)

The E.M.F. produced by the Passage of Steam through Narrow Tubes [Quantitative Investigation].—A. Milhoud. (*Comptes Rendus*, 30th April, 1934, Vol. 198, No. 18, pp. 1586–1588.)

Electronic Aids for the Blind [Photocell "Guides": "Talking Book," using Special 18-Minute Records: Federal Government Support].—Kleber. (*Electronics*, April, 1934, p. 107.)

Thyratron/Phanotron Relay Circuit for Use with Photocells, etc.—Babat. (*See* June Abstracts, p. 336, r-h column.)

The Technique of Photoelectric Titration [with Bibliography].—F. Müller. (*Zeitschr. f. Elektrochem.*, No. 1, Vol. 40, 1934, pp. 46–51: summary in *Electronics*, April, 1934, p. 126.)

The Application of Photoelectric Register Control [particularly in Paper-Bag Manufacture].—D. R. Shoults. (*Gen. Elec. Review*, April, 1934, Vol. 37, No. 4, pp. 170–174.)

Galvanometer Amplification by Photocell [Weston "Photronic"].—A. V. Hill. (*Nature*, 5th May, 1934, Vol. 133, pp. 685–686.) Continuation of the work referred to in 1932 Abstracts, p. 110, l-h column.

Photocells *versus* Bandits: Development of Equipment for Protecting Shop Windows.—G. E. C. (*Electrician*, 4th May, 1934, Vol. 112, No. 2918, p. 616.)

Photoelectric Train Control [System tested on German Railways].—O. P. van Steewen. (*Elec. Review*, 9th February, 1934, Vol. 114, pp. 187–188.)

A Colour Correction Filter for Photoelectric Photometry.—J. S. Preston and L. H. McDermott. (*Journ. Scient. Instr.*, May, 1934, Vol. 11, No. 5, pp. 150–157.)

Application of a Cuprous-Oxide Rectifier to a Microphotometer.—Asada. (*See* paper referred to under "Subsidiary Apparatus and Materials.")

The Rôle of the Structure of Tissues in Their Heating by Ultra-Short Waves.—Jellinek. (*Comptes Rendus*, 7th May, 1934, Vol. 198, No. 19, pp. 1723–1924.)

Further development of the work referred to in 1933 Abstracts, p. 463, r-h col. The experiments described (3 m waves) show that the heating mechanism is of a special nature; that besides the *internal* factors of the substance (physico-chemical structure, dielectric constant, etc.) and the *external* factors of the electrical field (wavelength, power, dimensions of field, etc.) there are conditions at present unknown which play an important rôle, connected with the distribution and environment of the substance. For example, the way in which the heating effect on patients may be influenced by the neighbourhood of cavities filled with air ought to be investigated carefully.

A Case of Lead Poisoning traced to Water lying overnight in a Lead Pipe used as an Earth Connection.—A. Strotmeyer. (*Zentralblatt f. Gewerbehygiene*, 1933, p. 234: summary in *Radio, B., F. für Alle*, April, 1934, No. 146, p. 65.)

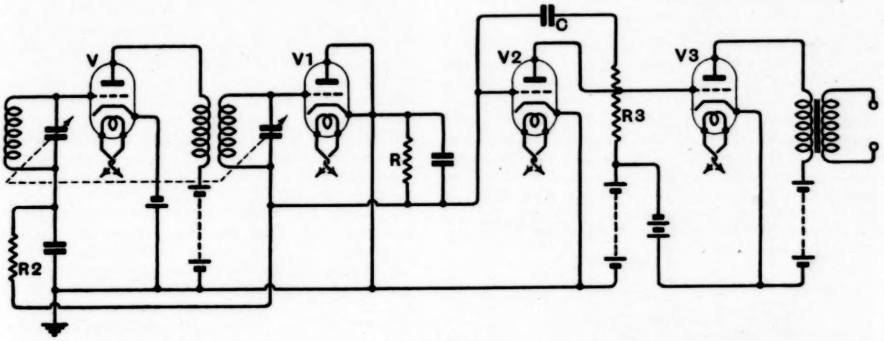
Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

AUTOMATIC GAIN CONTROL

Convention date (U.S.A.), 6th April, 1932.
No. 405124

The anode and cathode of the valve *V1* are strapped together to serve as a diode rectifier, and the rectified voltage across the load resistance *R* is applied through *R2* to the grid of the H.F. amplifier *V*. The valve *V2* acts as a noise suppressor or cut-off for the first LF stage *V3*. With no signal input, the grid and anode of *V3* are substantially at the same potential, so that the output current is high and sufficient negative bias is applied from resistance *R3* to prevent the amplifier *V3* from passing inter-channel " noise " through to the loud speaker. When signals arrive, the grid-biasing voltage drops and the valve *V3* then functions normally as a low-frequency amplifier. Audio-frequency signals are transferred through the coupling condenser *C*. By using a screen-grid valve at *V2*, the cut-off level can be regulated by adjusting the S.G. voltage.



No. 405124.

Patent issued to Hazeltine Corporation.

AIRCRAFT WIRELESS

Convention date (Germany), 19th April, 1932.
No. 405727

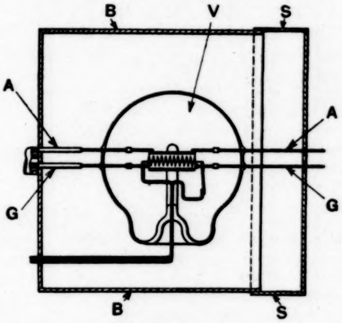
A wireless beam for marking out a route through the air for aeroplanes is radiated from a dipole aerial associated with a series of " modulating " reflectors. The main aerial is energised directly from a high-frequency source, while the course-indicating modulations are applied by alternately tuning and detuning the reflecting aerials. This is effected by opening or closing a contact in the centre of each dipole reflector, through relays operated from a master commutator switch.

Patent issued to C. Lorenz Akt.

MICRO WAVE SIGNALLING

Application date, 4th August, 1932. *No.* 405330

In generating or receiving waves of the order of centimetres by means of a valve operating on the so-called Barkhausen-Kurz method, tuning is usually effected by regulating the grid and anode potentials, thereby controlling the speed of the electron movements inside the bulb. According to the invention, a further control, which serves to increase the output and to reduce radiation losses, is secured by mounting the valve *V* together with the anode and grid connections *A*, *G* inside a screening box *B* which is fitted with a telescoping lid *S*. Optimum working conditions are then obtained by sliding the lid *S* in or out, so as to adjust the size of the enclosed space.



No. 405330.

Patent issued to International Communication Laboratories, Inc., and A. G. Clavier.

LOUD SPEAKERS

Application date, 12th August, 1932.
No. 405697

A "composite" loud speaker unit comprises a moving-coil unit fitted with a baffle-plate which also forms one of surfaces of an electrostatic speaker. This gives a compact form of "dual" speaker capable of handling a wide range of musical frequencies. By making the baffle-plate sufficiently large, it can be used as the projection screen for a talking cinema-film; or as the viewing screen for television.

Patent issued to R. A. Lewis.

SUPERHET SETS

Application date, 10th November, 1932.
No. 405768

In a superhet set designed to cover three different wave bands between 170 and 15 metres, the feedback coupling in the local oscillator includes a frequency-determining circuit. The coupling is partly magnetic and partly capacitive, the former predominating on the shortest waves and the latter on the longest waves, whilst on the intermediate wave-band the coupling is mixed. The capacity part of the feedback consists of a series of parallel condensers located in the common part of the anode-cathode and grid-cathode circuits. The condensers are switched in by the main tuning-control knob, which simultaneously lights a coloured lamp to indicate the particular wave-band which is in circuit.

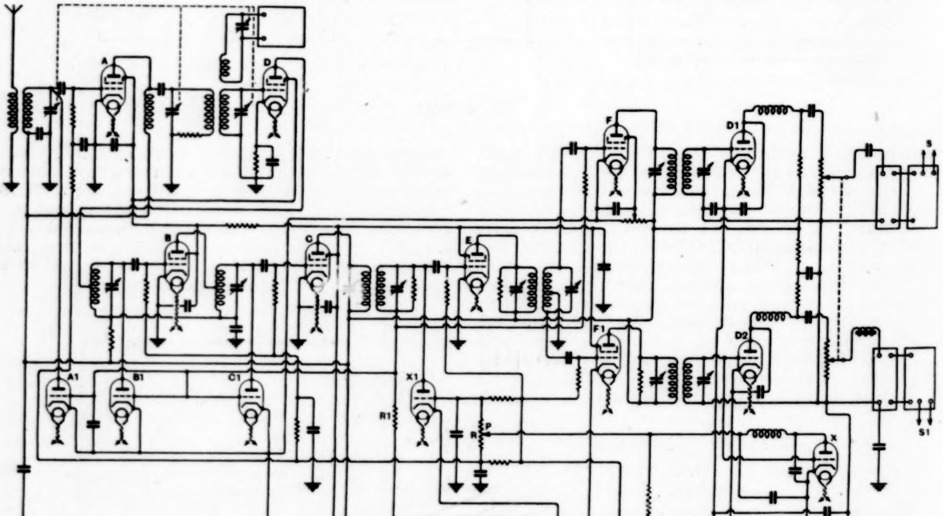
Patent issued to H. G. C. Fairweather.

SELECTIVITY AND TONE CONTROL

Convention date (U.S.A.), 29th July, 1932.
No. 405897

The selectivity of a receiver is automatically increased when distant signals are being received, and means are also provided for maintaining tone fidelity and for cutting-out carrier interference of the "intermittent steam-jet" type. Sensitivity is regulated by automatically varying the effective impedance of valves $A1$, $B1$, $C1$ (shunted across the tuned input circuits of the amplifiers A, B, C) in accordance with the level of the incoming signals. The output from the first detector D is fed to the amplifiers B, C, E, and is then split into two channels (*a*) through amplifier F, and second detector $D1$, to a "high-note" speaker S, and (*b*) through amplifier $F1$, and second detector $D2$, to a "low note" speaker $S1$. An auxiliary valve X controls the grid bias on the H.F. stages, and also that on the selectivity-control valves A, B, C. A second auxiliary valve $X1$ is shunted across the input of the amplifier E, and also controls the grid bias on the amplifier F through a resistance $R1$. When the slider P is at the lower end of resistance R, the sensitivity of the valves A, B, C is reduced, and the damping effect of valves $A1$, $B1$, $C1$ is pronounced, so that the tuning is broad. When the slider at the upper end of the resistance R these conditions are reversed. At the same time the higher impedance of the valve $X1$ tightens the coupling between the amplifiers C and E to increase the low-note response.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

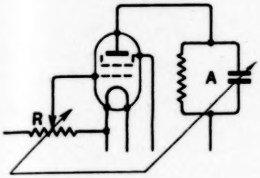


No. 405897.

CONSTANT AMPLIFICATION CIRCUITS

Convention date (Germany), 17th November, 1932. No. 405517

It is known that variations in tuning alter the circuit impedance, and therefore the effective amplification factor of the valve. To offset this the ratio of the internal resistance of the valve to the external anode impedance is automatically varied to produce a compensating effect. As shown in the Figure, the condenser of the tuned anode circuit *A* is connected to a variable grid-bias resistance *R* so that as the circuit *A* is tuned to a higher frequency, the grid-bias is altered (*a*) to increase the internal resistance of the valve and (*b*) to decrease its mutual conductance.



No. 405517.

Patent issued to N. V. Philips Gloeilampen Fabrieken.

MICROPHONES

Convention date (U.S.A.), 20th May, 1932. No. 405497

A ribbon microphone with a highly directive pick-up is designed so that part of it responds to the velocity of pressure gradient of the incident sound-wave, whilst a second part responds only to the instantaneous pressure component of the wave. The effect is produced by providing a pipe or conduit in close proximity to the back and upper part of the ribbon, the pipe being preferably packed with loose felt to prevent end-reflection. Ventilating slots are also formed in each of the pole-pieces.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

CATHODE-RAY TUBES

Convention date (Germany), 28th July, 1932. No. 405892

To maintain the same degree of deflection-control for all values of the electron stream, an annular electrode is interposed between the fluorescent screen and the deflecting-plates, and is supplied with a biasing potential which fluctuates with the strength of the discharge stream. For instance, the additional electrode may be coupled to the A.C. voltage supplied to the Wehnelt cylinder, or to any electrode which receives signal voltage. The coupling resistance is such that no appreciable voltage-drop is produced by the return current due to " spray " electrons.

Patent issued to M. von Ardenne.

" BLIND " FLYING BY RADIO

Convention date (Germany), 22nd September, 1932. No. 406144

To facilitate landing in foggy weather the radio " guide line " formed by two overlapping fields is interrupted near the aerodrome by two vertically-radiated fields which contain a " dead " zone to indicate to the aviator the point at which the downward flight should be commenced. Immediately afterwards, he enters an inclined " beam " formed by the overlapping fields from two groups of dipoles set at an angle to each other. This guides him down to earth.

Patent issued to C. Lorenz Akt.

PENTODE VALVES

Application date, 18th June, 1932. No. 406292

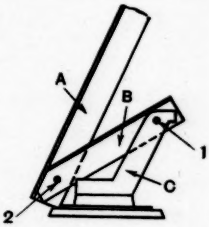
The suppressor grid is connected through a resistance either to the cathode, screening-grid, or anode in such a way that a biasing potential is applied to the suppressor grid which is derived solely from the voltage drop across the series resistance. The coupling resistance may be mounted inside the glass bulb, or in the base of the valve. By giving the suppressor grid a positive potential less than that of the anode the mesh of the grid can be made smaller than usual, and the electron flow between anode and cathode is facilitated.

Patent issued to S. F. Warren and W. L. J. Woods.

PICK-UP ARMS

Application date, 16th August, 1933. No. 405904

The arm is made in two portions *A*, *B*, both U-shaped in section. The part *B* is pivoted at 1 to the support C, and is adapted when the arm is in its normal horizontal position to fit completely inside the part *A*. The latter is pivoted at 2 to to rotate about the arm *B*, so that it can be brought into the position shown in the Figure for needle-changing.



No. 405904.

Patent issued to N. Meoni.

TELEVISION TRANSMITTERS

Application date, 25th August, 1932. No. 406353

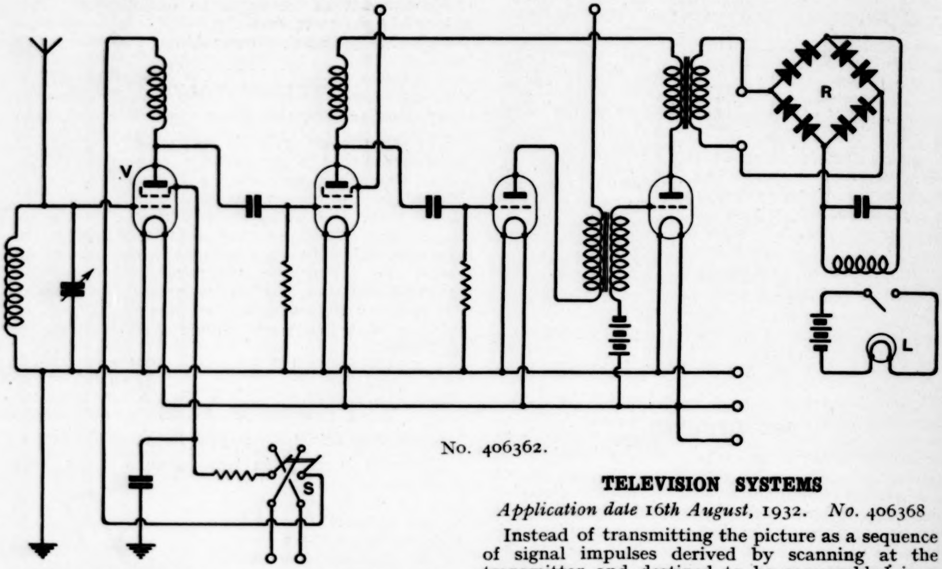
Relates to cathode ray tubes of the kind in which an image of the picture to be televised is projected upon a " mosaic " of photo-sensitive cells, prior to scanning. According to the invention the photo-sensitive material is applied to the electrode surface when the latter is *in situ* inside the glass bulb. A pellet of silver is first vapourised by an electric current, and the vapour is deposited on the electrode through a fine wire mesh temporarily fitted to the latter, so that the deposit takes the form of a " mosaic " of small discrete squares. The wire mesh is next removed by a pair of pincers, and the tube is then evacuated to drive-off occluded gas. A small quantity of oxygen is next admitted to oxidise the silver, and finally a layer of caesium is distilled over the silver to complete the sensitive " cell " surface.

Patent issued to Electrical and Musical Industries, Ltd. ; W. F. Tedham ; and J. D. McGee.

WIRELESS "CALL" SYSTEMS

Application date, 26*th August*, 1932. *No*. 406362

A receiving set is designed to give automatic warning of the receipt of an incoming signal, as for instance in the case of a message radiated from police headquarters to all sets on mobile patrol. According to one method a coil in the output of a low-frequency amplifier is back-coupled to the input circuit of the first H. F. valve, so that on the receipt of the first signal a rectified pulse is modulated on the incoming carrier-wave. The back-coupling process continues until the rectified output is sufficient to operate an audible or visible signal, whereupon the back-coupling coil is manually switched out of circuit, to give normal reception. Alternatively, as shown in the Figure, a stand-by switch *S* feeds 60 volts to the anode and 120 volts to the screening-grid of valve *V*, so that the latter oscillates and produces a heterodyne beat-note with the incoming signal which is rectified at *R* to light a lamp *L*. Thereupon the operator reverses the switch *S* to place 120 volts on the plate and 60 volts on the screening-grid, so that the set functions as a normal receiver.



No. 406362.

Patent issued to Standard Telephones and Cables, Ltd.; B. J. Axten; and D. Hamilton.

VALVE ELECTRODES

Application date 29*th August*, 1932. *No*. 406659

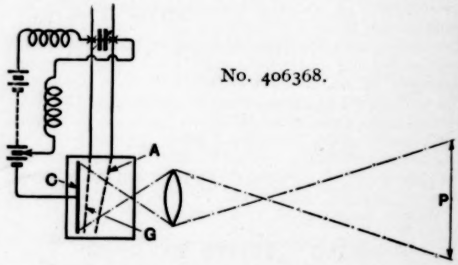
Instead of providing the usual earthed suppressor-grid to avoid the falling-current characteristic in a four-electrode valve, the same object is secured by forming the anode with edges or projections which face towards the control or accelerating grid. This is stated to reduce the probability of secondary electrons leaving the anode in the direction of the grid, and to increase the chance of such electrons falling back on to the anode.

Patent issued to J. H. Edwards.

TELEVISION SYSTEMS

Application date 16*th August*, 1932. *No*. 406368

Instead of transmitting the picture as a sequence of signal impulses derived by scanning at the transmitter and destined to be reassembled in a two-dimensional frame by a similar scanning operation at the receiving end, the whole of the picture is radiated simultaneously in the form of a complex of waves, each picture "point" being carried by a wave of definite frequency. The method depends upon the use of a valve oscillator of the Barkhausen-Kurz type, in which each frequency generated is a function of the spacing of the electrodes. The cathode *C* of the oscillator is a photo-sensitive surface upon which the picture *P* is focussed. The other electrodes *A*, *G* are set at a "slope" to the cathode so that each point of emission on the latter generates its own frequency. A similar type of valve is used in reception to sort out each incoming frequency and allot it to its proper point on the reconstructed picture.



No. 406368.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.; H. M. Dowsett and R. Cadzow.